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ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP), EUROPE

FOR

DEPARTMENT OF THE ARMY
EUROPE DIVISION, CORPS OF ENGINEERS

BY

POPE, EVANS AND ROBBINS INCORPORATED
ENERGIECONSULTING HEIDELBERG GMBH

ENERGY ENGINEERING ANALYSIS (EEA) PROGRAM

EUROPE

WIESBADEN MILITARY COMMUNITY

VOLUME I: EXECUTIVE SUMMARY

FINAL SUBMISSION

JULY 1983

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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VOLUME I - EXECUTIVE SUMMARY

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1.0 INTRODUCTION

This energy study of the Wiesbaden Military Community was authorized by the Department of the Army, Office of the Chief of Engineers as part of an Energy Engineering Analysis (EEA) Program. Overall program management rests with the Huntsville Division Corps of Engineers while contract management was performed by the Europe Division, headquartered in Frankfurt, West Germany.

The locations of the Wiesbaden area installations studied are shown on the vicinity map in Figure 1.1. Nearly all the facilities not located at the Wiesbaden Air Base living quarters and community support buildings for military personnel and their dependents.

The general function of the larger categories of buildings studied are as follows:

Building Function	Number of Bldg.
Family Housing	300
Repair Shops and Warehouses	32
Community Services (stores, schools, clubs, chapels, etc.)	30
Barracks and Mess Halls	29
Administration	25

VICINITY MAP
WIESBADEN AIR BASE

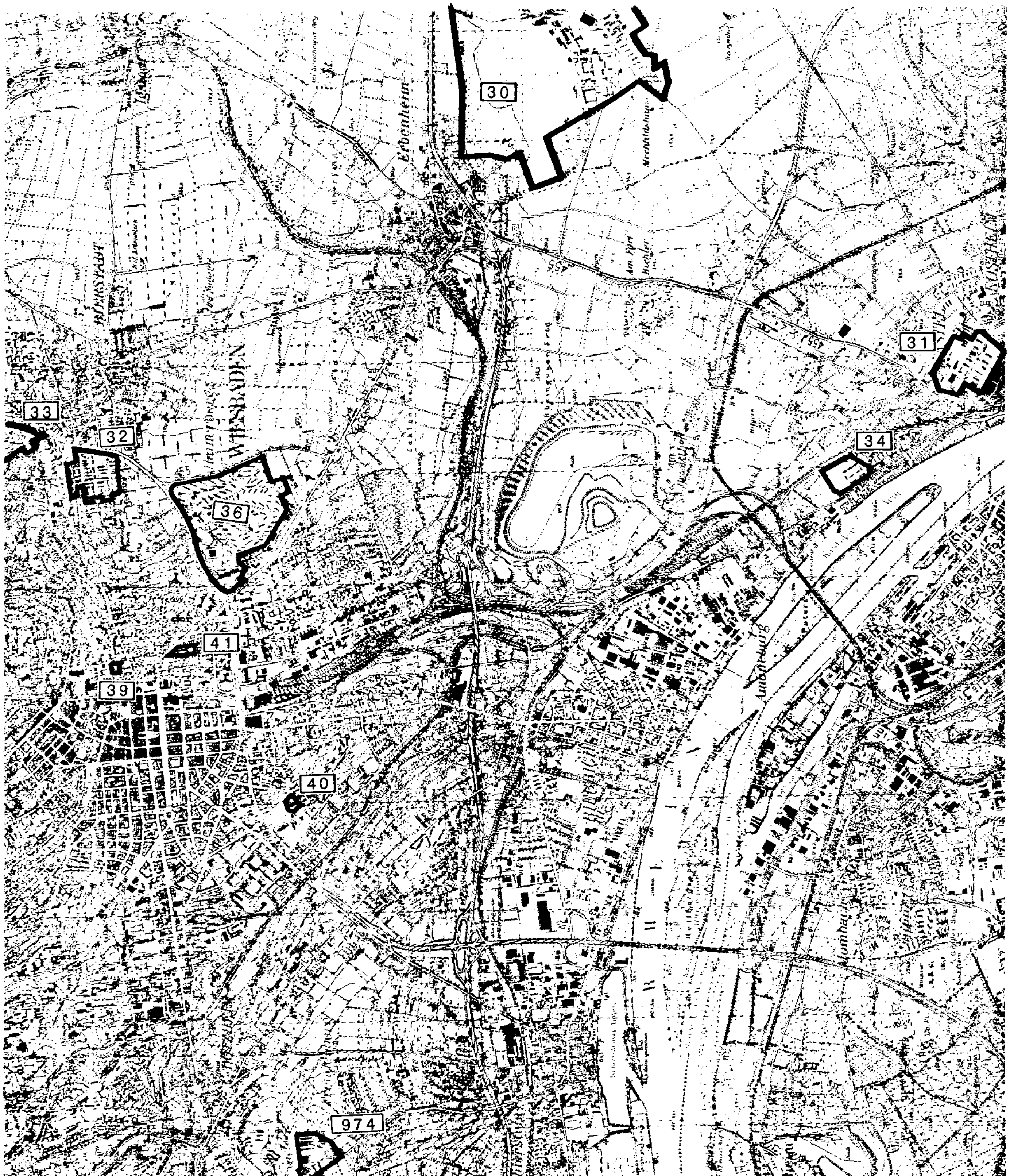


FIGURE 1.1

The objectives of this Energy Study, in accordance with the "Schedule of Title I Services for Energy Engineering Analysis Program, Europe", 13 December 1980, are as follows:

a. Develop a systematic plan of projects that will result in the reduction of energy consumption in compliance with the objectives set forth in the Army Facilities Energy Plan, without decreasing the readiness posture of the Army.

b. Use and incorporate applicable data and results of related studies, past and current as feasible.

c. Develop a coordinated basewide energy plan.

d. Prepare Program Development Brochures (PDB), DD Forms 1391, and supporting documentation for energy conservation projects which meet Energy Conservation Investment Program (ECIP) funding criteria.

e. Include in the program studies all methods of energy conservation which are practical (insofar as the state-of-art is reasonably firm) and economically feasible in accordance with guidance given.

The long term objective is to implement a policy of becoming as energy self-sufficient as the state-of-the-art for energy conservation will allow within our resources and economic bounds set by the full implementation of our national energy policy as prescribed by the Army Facilities Energy Plan (dated 1 Oct 1978). See Exhibit 6.4.

The Energy Engineering Analysis (EEA) for Wiesbaden Military Community includes Increments A, B, G and F of Title I Services, defined as follows:

Increment A: Energy Conservation Opportunities(ECO's) which fall under the Energy Conservation Investment Program (ECIP) for buildings and processes.

Increment B: ECIP projects for utilities, energy distribution, Energy Management Control Systems (EMCS) and the use of waste fuels.

Increment G: Operation, maintenance, repair and minor construction projects for energy conservation.

Increment F: Recommendations for modifications of facilities' system operations.

Data was collected on the design and condition of the physical facilities during detailed field surveys of representative buildings. Energy consumption characteristics were defined using information furnished by the community and by field measurement and data collection. A survey program, covering all buildings, was carried out to identify ECO's in the operation and maintenance of the utility systems.

Collected data was analyzed to identify the energy conservation opportunities, which fall into the above work increments, and to predict the savings which could result from repairs and improvements. A major part of the analyses focused on comparing theoretical energy requirements for the buildings with the reported energy consumption. The BLAST computer program was used to compute heat loads for buildings,

while a custom program was developed to combine the effects of energy conversion and distribution efficiency with the theoretical heat loads and known fuel consumptions. The latter program produced the fuel distribution report for each major heating system and characterized the loads at each installation.

The energy consumption characteristics of the Wiesbaden Military Community are typical of the installations throughout West Germany which provides a complete working and living environment for military personnel and their dependents. In contrast to many military facilities in the United States, the installations in Wiesbaden have no air conditioning for comfort cooling. Energy loads can be broadly classified into several groups as follows:

Thermal

- space heating
- domestic hot water
- process (gas for cooking and laundry)

Electrical

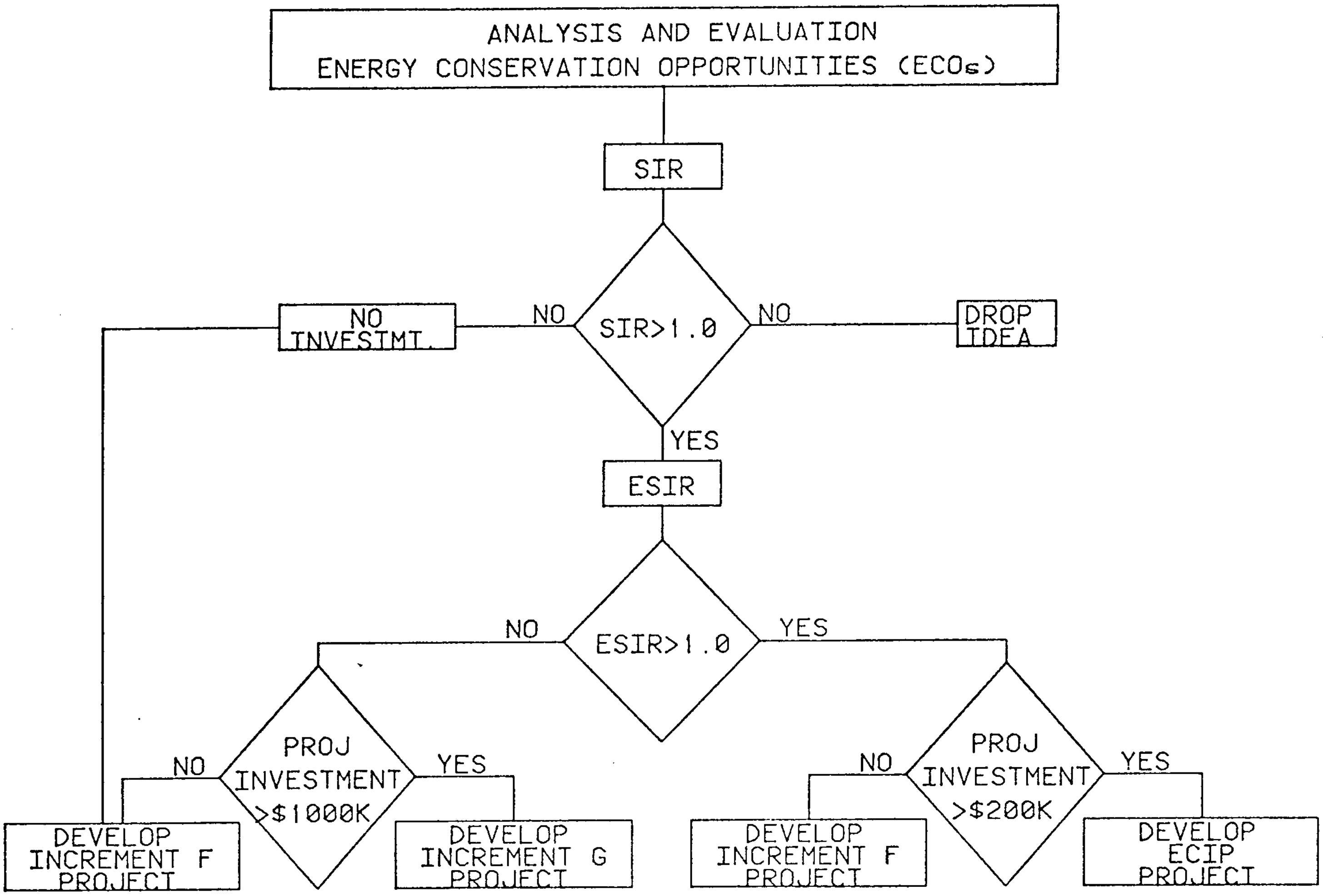
- lighting
- domestic appliances
- clothes dryers
- utility system motors
- shop and store equipment

Thermal and electrical loads at the studied installations peak in mid-winter and are lowest in mid-summer, as expected. Electrical loads peak during normal work day hours and follow typical patterns for a residential plus commercial community in a Northern climate. Weekend electrical load peaks are much smaller than weekday peaks, indicating that work areas are effectively shut down on weekends.

Based on the physical facilities and the energy load characteristics, ECO's were developed and analyzed for feasibility in accordance with FY 85 ECIP Guidance. Figure 1.2 shows the Project Flow Diagram indicating the economic analysis of an ECO. A systematic approach considering primary energy conversion, energy distribution, and energy utilization was employed to assure that the opportunities for energy savings would be identified. Special attention was given to state-of-the-art energy technology for conservation, management, and alternatives to the use of fossil fuels.

In cooperation with the Community (Conference of 8 March 1983 held at Wiesbaden Air Base), the A/E developed ECIP programming packages based upon study recommendations. DD Forms 1391 were prepared and submitted to the Community on 29 April 1983 for approval.

Detailed field survey data which served as the basis of the energy engineering analysis was previously submitted to the Wiesbaden Community in a series of data report volumes. The contents of the interim submission, Volume I and II for increments A, B, and G, and the contents of the preliminary submission for increment F are combined and updated in this report.



NOTES:
1. SAVINGS TO INVESTMENT RATIO (SIR) CALCULATED AS PER NEW ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) GUIDANCE.
2. CALCULATE ENERGY SAVINGS TO INVESTMENT RATIO (ESIR) USING THE LOWER NUMBER:
   (ENERGY $ SAVINGS + 0.33 ENERGY $ SAVINGS)/INVEST
   (ENERGY $ SAVINGS + 0.33 ENERGY $ SAVINGS)/INVEST

2.0 EXISTING ENERGY CONSUMPTION

Energy consumption in FY 1975 is the baseline against which the reduction of energy consumption is measured. FY 1980 energy consumption data was used as a reference year for the EEA study. Energy consumption data for the Wiesbaden Military Community for both these years is shown in Table 2.1. This data was provided by the office of the Director of Engineering and Housing, Headquarters V-Corps. The FY 75 consumption data was presented to the A/E as the baseline against which energy conservation performance will be measured; these figures reportedly exclude all fuel consumption from Air Force installations in Wiesbaden.

To characterize the fuel consumption of the Wiesbaden Military Community, data for three fiscal years is compared. Figures 2.2 through 2.4 show the consumption profiles for individual fuels for FY 75, FY 79 and FY 80. Figure 2.5 shows the total electrical consumption of the largest electrical system, Wiesbaden Air Base; this is broken down to on-peak consumption and off-peak consumption relating to the utility's time-of-day rates. On-peak consumption ranges from approximately 430,000 kWh to 850,000 kWh per month and off-peak ranges from 210,000 kWh to 480,000 kWh per month.

The BLAST program was used to characterize the energy consumption of individual buildings. Annual fuel consumption profiles for specific buildings with typical functions and design day load profiles for representative types of buildings in Wiesbaden are presented in Section 3, Volume II: Figures 2.7 and 2.8 are typical. The building types indicated on the design day load profiles are the classifications used in the Fuel Distribution Program (FDP) previously mentioned. Estimated distribution of the fuel consumption by building and load type is provided in Section 3, Volume II of the report.

TABLE 2.1

Baseline and Reference Energy Consumption Data
(Based on 9.294×10^6 SF Occupied Area)

	FY 1975		FY 1980	
Fuel Type	Quantity	Consumption	Cost $/MBTU	Consumption
Anthracite Coal	18,606 Metric Tons	530,271 MBTU*	3.36	447,067 MBTU*
Bituminous Coal	11,302 Metric Tons	354,927 MBTU*	2.60	337,727 MBTU*
Heating Oil No. 2	911,500 Liters	156,967 MBTU*	8.42	162,790 MBTU*
Natural Gas	40,635 K.C.F.	41,855 MBTU*	11.74	35,956 MBTU*
Propane (Liquid)	58,240 Gal.	5,533 MBTU*	9.74	8,901 MBTU*
Electric	37.7×10^6 kWh	429,552 MBTU*	4.48	437,436 MBTU*
TOTAL (MBTU)		1,519,075		1,429,877
KBTU/sq.ft./yr.		163.45		153.85

* MBTU = 10E6 BTU

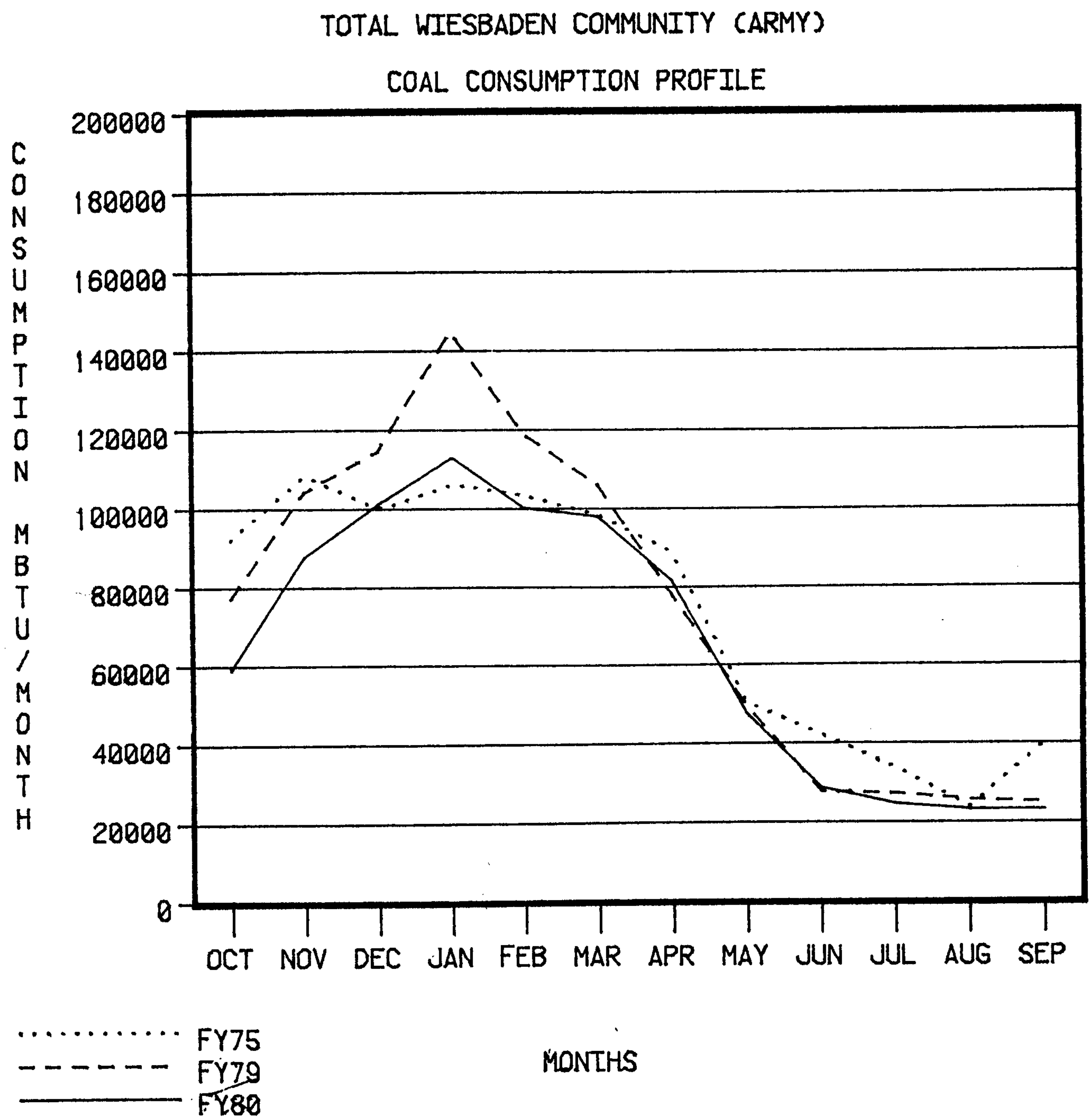

TOTAL WIESBADEN COMMUNITY (ARMY)
COAL CONSUMPTION PROFILE
CONSUMPTION MBTU/MONTH
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FY75
FY79
FY80
MONTHS

Figure 2.2

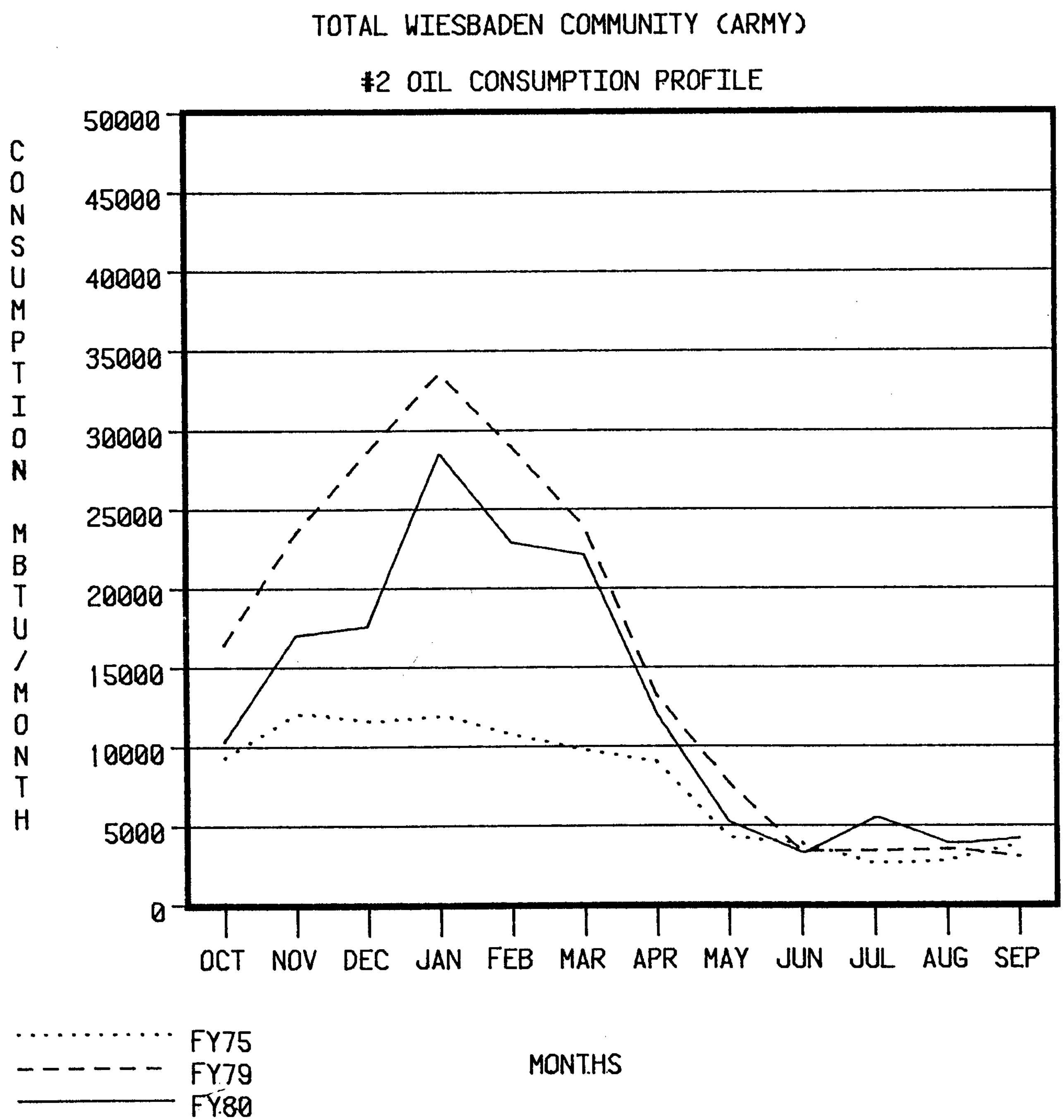

TOTAL WIESBADEN COMMUNITY (ARMY)
#2 OIL CONSUMPTION PROFILE
CONSUMPTION MBTU/MONTH
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
FY75
FY79
FY80
MONTHS

Figure 2.3

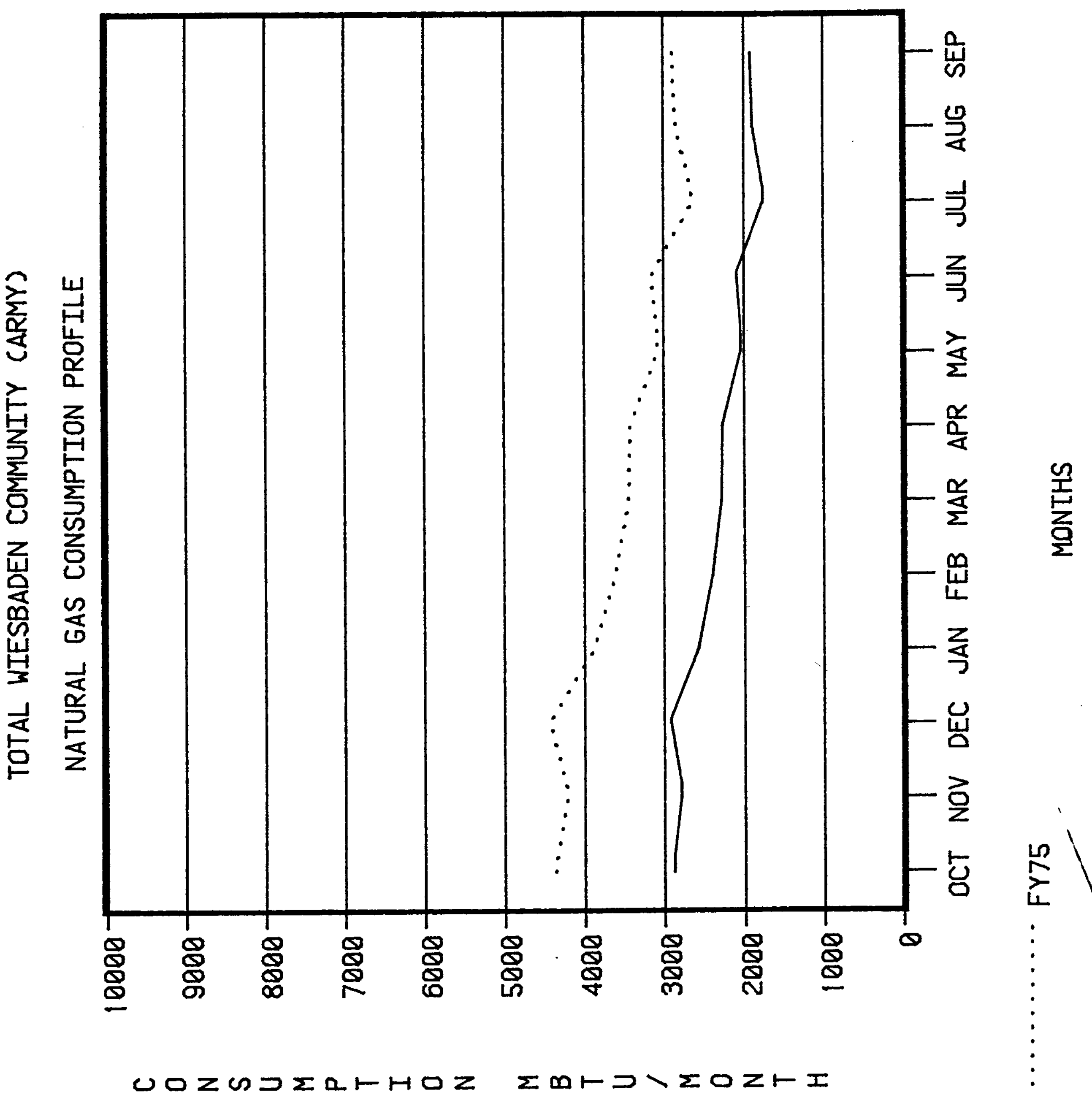

TOTAL WIESBADEN COMMUNITY (ARMY)
NATURAL GAS CONSUMPTION PROFILE
CONSUMPTION MBTU/MONTH
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
MONTHS
FY75
FY80

Figure 2.4

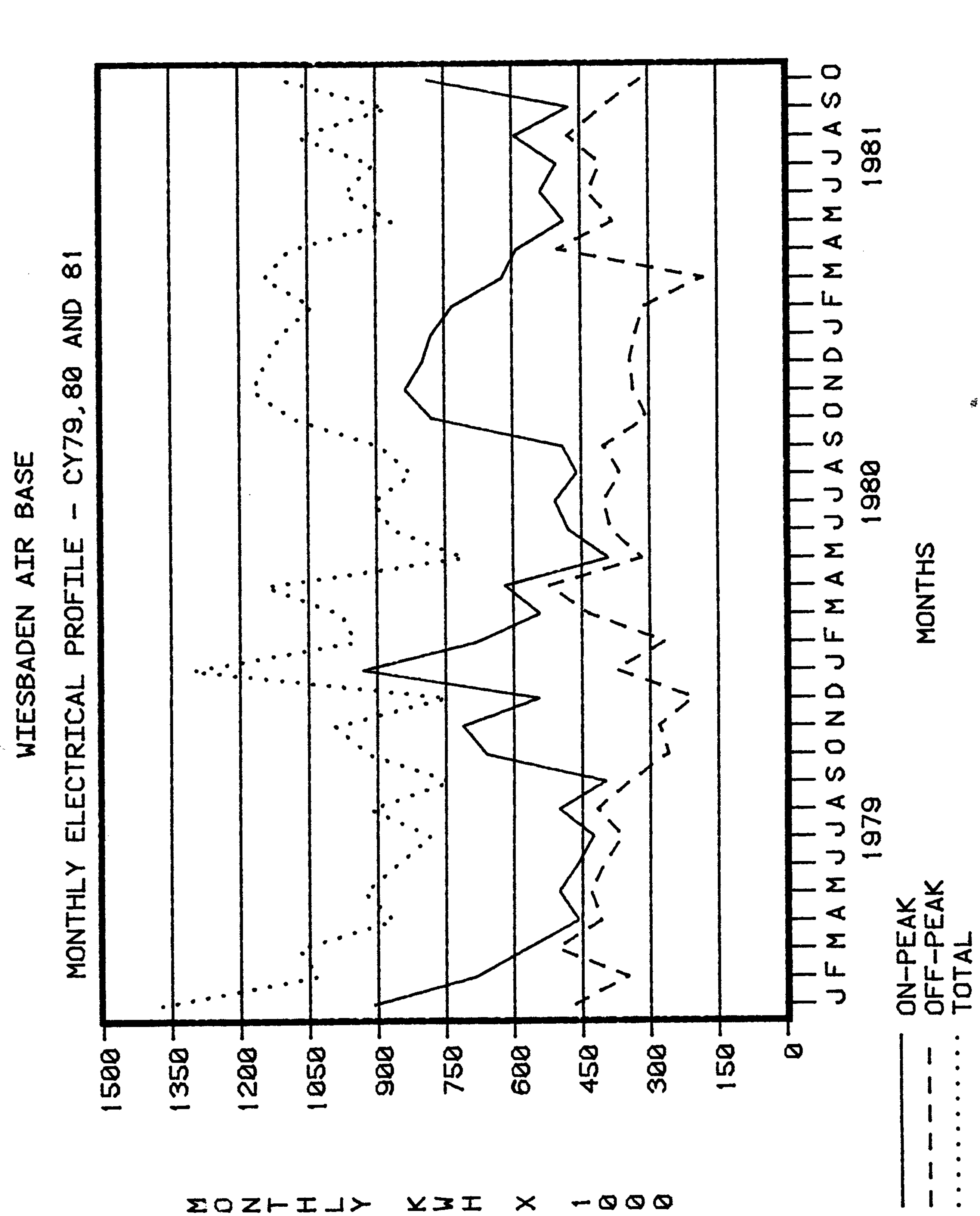
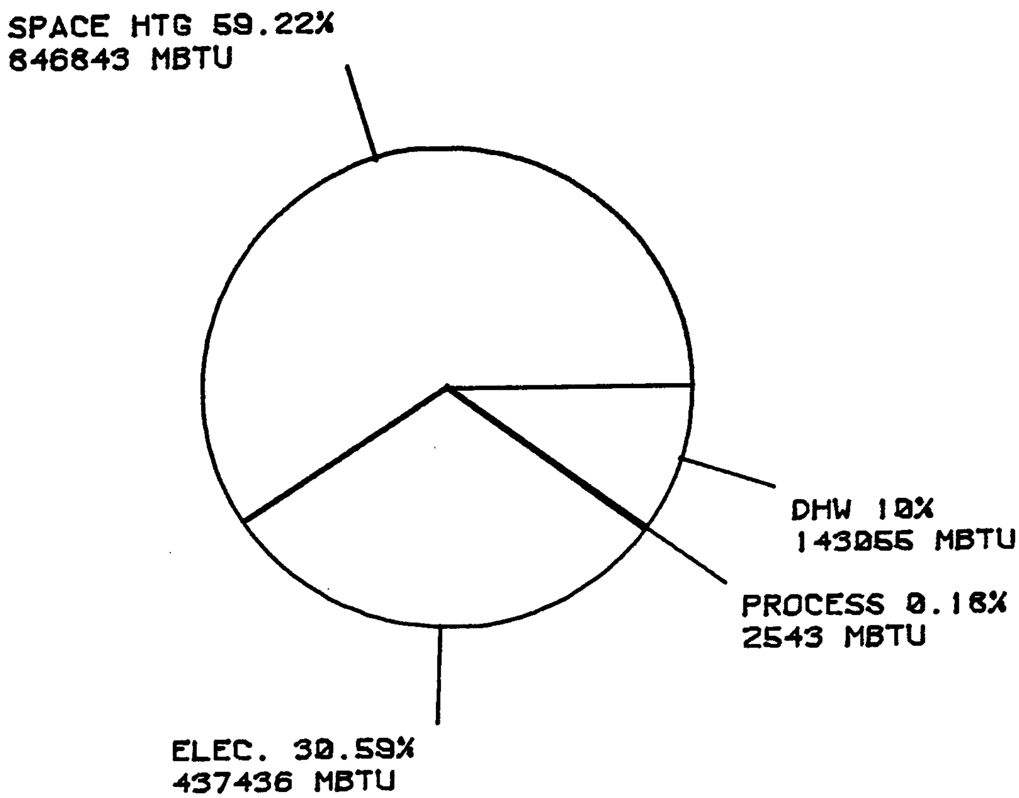


Figure 2.5

ELECTRICAL LOAD PROFILES, WIESBADEN AIR BASE

FIGURE 2.6

WIESBADEN MILITARY COMMUNITY
TOTAL ENERGY CONSUMPTION (FY 80)
(V-CORPS DATA)



TOT. ENERGY CONS.=1,429,877 MBTU (162,790 MBTU #2 OIL; 44,857 MBTU PROPANE & NAT.GAS; 784,794 MBTU COAL; 437,436 MBTU ELEC.)

ADMINISTRATION BUILDING

ANNUAL CONSUMPTION PROFILE: BUILDING #1067

WIESBADEN AIR BASE

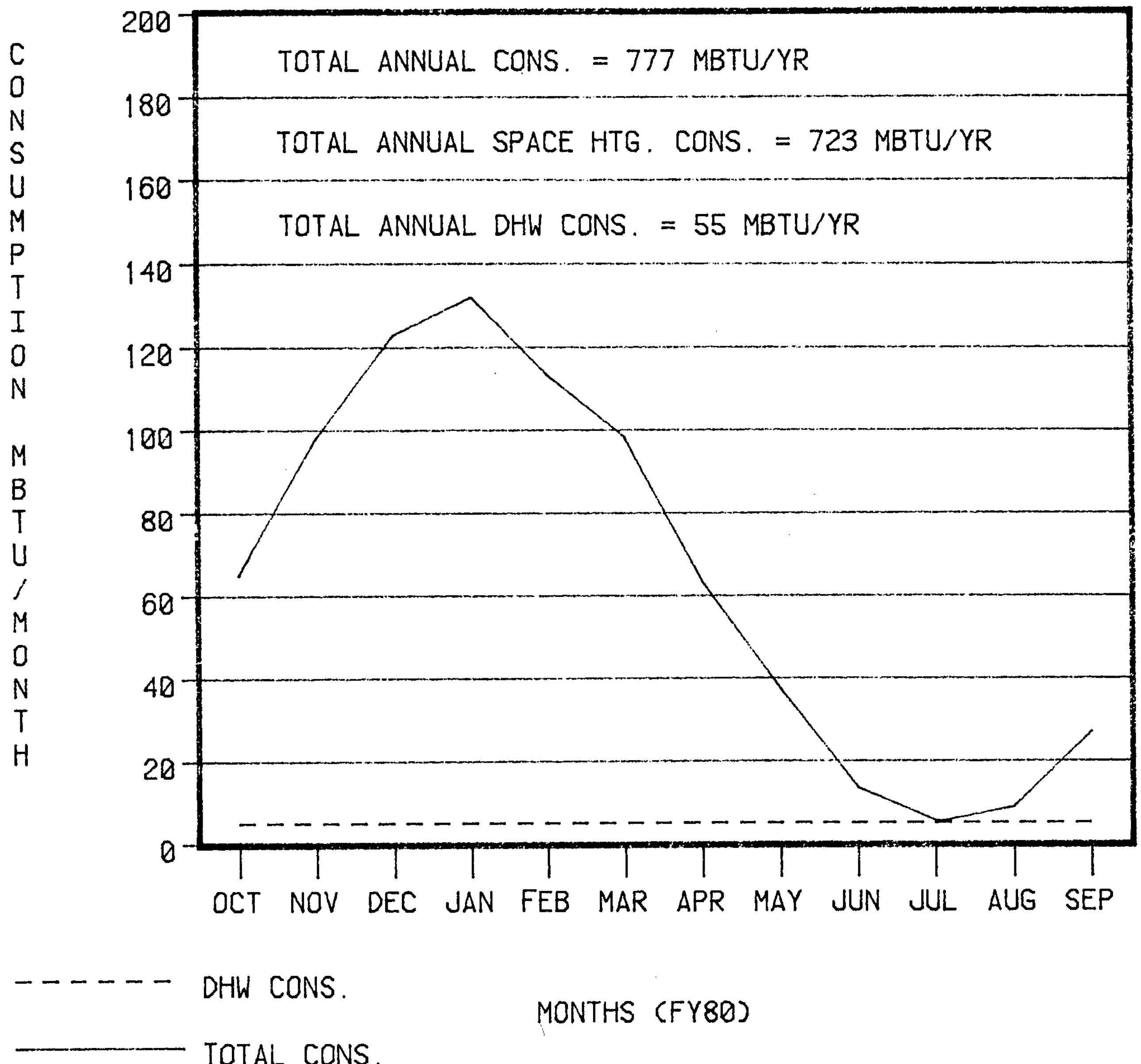
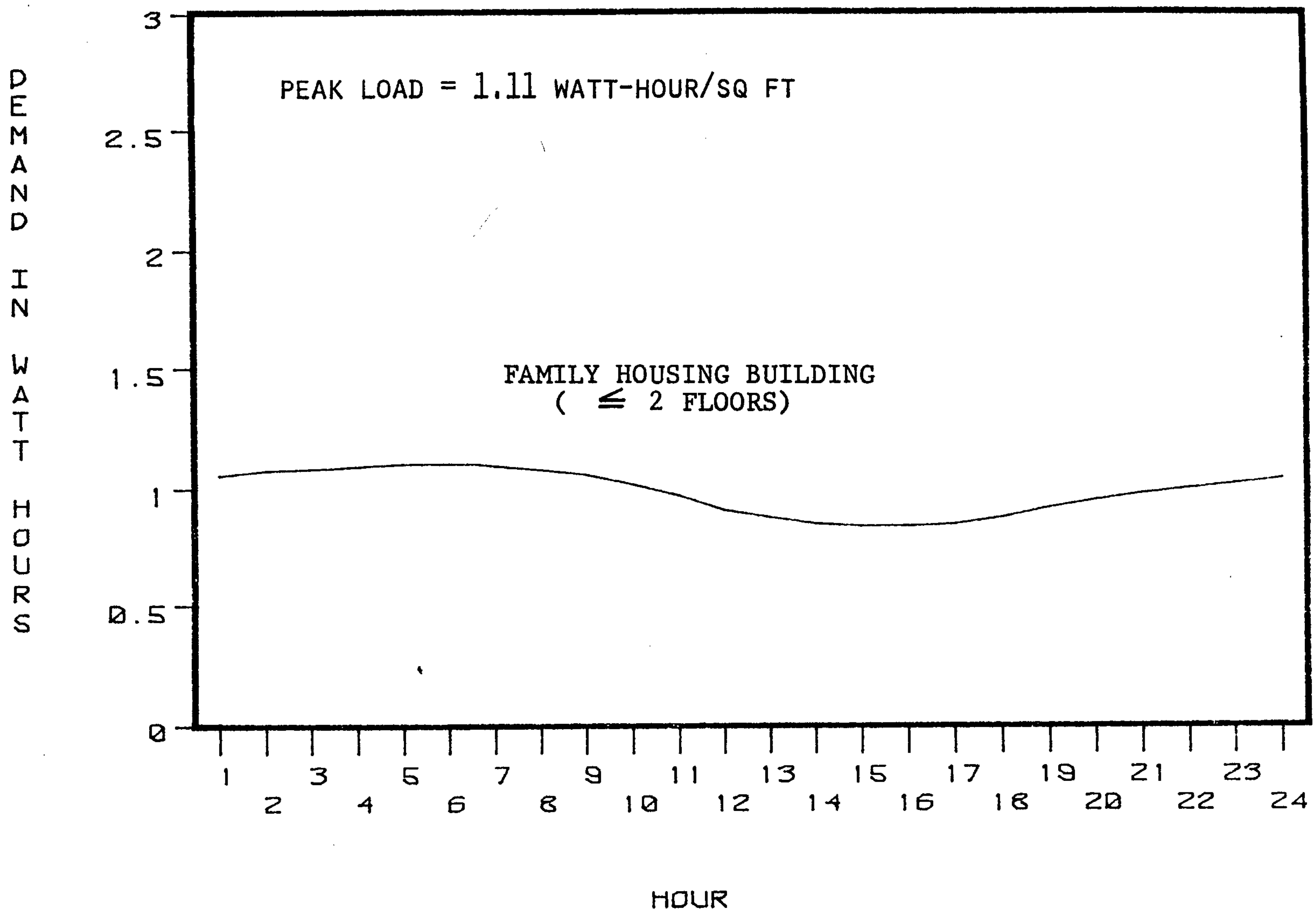


Figure 2-7

WIESBADEN MILITARY COMMUNITY

BLDG TYPE 1: DAILY LOAD PROFILE FOR DESIGN DAY*



* LOAD PROFILE CALCULATED BY "BLAST"

Figure 2-8

3.0 ENERGY CONSERVATION OPPORTUNITIES DEVELOPED

As described under the Methodology Section, Volume II: Study Report, based upon record data provided by the community, detailed site surveys and discussions with Facilities Engineering personnel, all practical energy conservation measures were technically and economically evaluated to determine if they met ECIP criteria. The "Energy Conservation Options" listing for Climate Zone 3 (3000 -6000 degree days) in Annex E of the Army Facilities Energy Plan was used as a starting list of possible conservation measures; this list, modified to be applicable to installations in West Germany, is presented in Section 4, Volume IV: Appendix. Recommended modifications which were not on the list include the installation of fans to prevent hot air stratification, installation of thermal barriers for windows in intermittently occupied buildings, installation of domestic hot water heat pumps and installation of turbulators in firetube boilers.

Based upon recommendations made by the A/E in the Interim Submittal and agreements reached at the conference of 8 March 1983, held at Wiesbaden Air Base, recommended ECIP projects were packaged and project documents developed for ECIP funding in accordance with FY 85 criteria. Those energy conservation measures are described hereafter; ECO numbers and titles correspond to those presented in Section 4 of Volume II.

ECO No. 41112: Vestibule

By constructing a new exterior door and passageway in front of an existing exterior door the infiltration of outside air into a building is significantly reduced. Vestibules are cost effective at door locations which are frequently used.

ECO No. 41121: Roof Insulation

Heat load analysis leads to the recommendation of roof insulation for many buildings. Building roofs generally have higher heat loss and lower insulation cost per square foot than walls. The best type of insulation is determined by the configuration and the utilization of the attic space.

ECO No. 41141: Double Glazed Windows

A significant portion of energy loss through a building envelope is due to windows. Heat Losses occur due to both conduction of heat through the glass and infiltration of outside air through window perimeter cracks. Where infiltration heat losses are excessive due to poor fitting windows, new double glazed tight fitting windows are recommended. Although weatherstripping can also reduce infiltration through windows, the life of the weatherstripping is very limited compared to carefully installed windows.

ECO No. 41142: Thermal Barrier for Windows

Many industrial, administrative, religious and recreational buildings are unoccupied for more hours per week than they are occupied. The addition of a thermal barrier can reduce large conduction losses during unoccupied periods making it economically attractive for certain buildings.

ECO No. 41151: Mess Hall Exhaust Air Heat Recovery

Ventilation standards for mess halls require a minimum of ten air changes per hour. Heat recovery units can be installed to preheat the intake air using the warm exhaust air and thus reduce heating fuel consumption. Where the ventilation systems are designed and operated to achieve the standard ventilation rates, heat recovery systems are cost effective.

ECO No. 41161: Laundry Exhaust Air Heat Recovery

Air which is used to dry clothes in a laundry is heated from a temperature of 70°F up to a temperature of 230°F. This hot air removes moisture from the clothes and is vented to atmosphere, carrying off a large amount of energy. Where the dryer capacity is sufficient and the hours of operation are high enough it becomes economical to recover a portion of this heat.

ECO No. 41211: Lighting System Replacement

The development of high efficiency lighting systems created opportunities for reducing the energy for lighting without reducing the illumination. In many lighting systems this can be accomplished by simply replacing the lamp. Slight modifications to existing fixtures are required for some conversions to high efficiency lamps.

ECO No. 41212: Improve Street Lighting Efficiency

Where field investigations show that existing street lights are mercury vapor, they can be replaced with high pressure sodium lamps with only minor fixture modifications.

ECO No. 42111: Thermostatic Radiator Valves

Thermostatic radiator valves regulate indoor temperature by controlling the heating fluid supply to radiators. Thermostatic radiator valves reduce localized overheating by compensating for interior and exterior heat gains other than the heating system and limit the maximum heat supply to a radiator.

ECO No. 42112: Building LTW Controls

Building temperature control systems are installed to adjust the heating water supply temperature to the radiators in a building. Overheating of buildings is reduced by regulating the supply temperature in response to weather conditions, and by improving heat distribution where buildings are part of a network.

ECO No. 42113: Building LPS Controls

Building heating system controls are installed to regulate the steam supply to the building terminal units in response to outdoor temperature. Overheating of buildings is thus reduced and steam pressure may be lowered to reduce distribution losses.

ECO No. 42121: Prevent Air Stratification

In large open areas with high ceilings, warm air rises creating a temperature differential between the floor and ceiling. If room air is vertically mixed, such as by ceiling fans, the air temperature stratification is reduced. A more uniform temperature results in less heat to maintain minimum temperature at the occupied floor level and less heat loss through the roof.

ECO No. 43111: Install Flue Gas Dampers

Burners in small oil and gas fired boilers are typically controlled by on-off or stepped firing rates. Natural draft of the flue gas exhaust continues to draw air through the boiler during burner shutoff resulting in the exhaust of heated air. Automatic dampers installed in the flue gas duct close when the burners are off, thereby eliminating unnecessary heat losses through the stack.

ECO No. 43131: Install Turbulators in Firetube Boilers

Overall efficiency of firetube boilers can be improved by the installation of turbulators in the steam generating tubes. Turbulators are deformed strips of steel which are inserted directly into the boiler firetubes to improve heat transfer by increasing the turbulence while reducing the velocity of gasses passing through the tubes. Turbulators can be installed with only minor adjustments to the burners and boiler controls.

ECO No. 43133: Combustion Controls for Central Automatic Coal Fired Heating Plant

Where annual plant loading is sufficient and the plant efficiency is low, an O_2/CO monitoring and trim system can be justified. This type of control will optimize combustion regardless of boiler type, operators experience or even fuel type.

ECO No. 43134: Install Boiler Feedwater Economizer

Where boiler flue gas temperatures are significantly higher than the minimum allowable temperature, the installation of a feedwater economizer will help to bring down the temperature to the minimum level and recover the large amount of energy being wasted.

The following projects were developed, even though they do not meet ECIP criteria, because they will serve to reduce Wiesbaden dependence on critical fuels; however, they will also increase the total fuel consumption. The Savings-to-Investment Ratios are greater than 1.0 but the Energy Savings-to-Investment Ratios are less than 1.0.

- ECO No. 43132: Conversion of Oil-Fired Central Heating Plants to Automatic Coal-Firing.

- ECO No. 43122: Conversion of Gas-Fired Domestic Hot Water Generators to Indirect DHW generators utilizing the heating medium.

Specific Operations and Maintenance Modifications were identified as follows:

- Load Shedding
- Power Factor Correction
- Repair Vent Dampers and Seal Miscellaneous Openings in Building Envelopes
- Reset Existing Heating System Controls and Thermostatic Valves
- Insulate Valves in Heating Plant
- Reduce Domestic Hot Water Temperature
- Repair of Leaks in the Hot Water and Steam Distribution Systems
- Insulate Hot Pipelines
- Reduce Heating in Unoccupied Areas
- Installation of Timers on Vending Machines
- Reduction of Lighting by Lamp Removal
- Install Additional Light Switches
- Add Timers to Light Switches
- Add Outdoor Light Controls

General Operatiaons and Maintenance Recommendations were made as follows:

- Night Temperature Setback
- Domestic Hot Water Flow Control
- Incandescent Lamp Replacement
- Optimize Transformer Loading

In addition to the above listed projects, developed to improve the efficiency of energy conversion, distribution and utilization, policy changes are recommended which can reduce energy consumption and/or operating costs:

- Improve communications between the users and the office of the facility engineer by means of an energy conservation coordinator of each installation and a monitor for each energy consuming building. The energy usage for each building should be recorded and discussed at regular meetings where policy for energy conservation performance can be evaluated.

- Educate the building occupants to minimize the use of lighting, domestic hot water and heat. All family housing lighting and some hot water heaters in individual dwelling units are controlled by building occupants. Although building controls and thermostatic valves can reduce overheating, windows and doors left open in the heating season cannot be eliminated by controls.

- Negotiate for reducing the cost of purchased electricity. Since utility rates are designed for an entire class of customers, a fair but more attractive rate may be considered negotiable for a specific load profile. Investigate the consolidation of electrical services which are billed under different rate schedules to achieve a more favorable rate structure.

- Institute procedures to assure that energy savings are considered in all new projects which are specified. When specific goals and guidelines are adopted, the facilities should be upgraded in a uniform manner with each repair or new construction project. All projects should be reviewed by the community energy coordinator to assure that these projects are consistent with energy plan goals.

- Specify energy conservation options for replacement equipment as follows:

  - high efficiency motors
  - high efficiency air conditioning units
  - automatic shut off controls for clothes dryers
  - improved gas oven insulation
  - improved insulation and other design features for domestic food refrigerators

4.0 ENERGY AND COST SAVINGS

Basewide energy consumption after implementation of the EEAP Energy Plan is projected to be 899,143 MBTU/yr; this is a 41% reduction in fuel consumption as compared to FY 75 energy consumption of 1,519,075 MBTU/yr.

The projected savings are allocated by fuel type as follows:

		ANNUAL CONSUMPTION (MBTU/yr)			SAVINGS
		FY 75	FY 80	FY 86	MBTU/YR
Electric	:	429,522	437,436	421,409	8,113
Natural Gas	:	41,855	35,956	35,745	6,110
No. 2 Oil	:	156,967	162,790	81,732	75,235
Coal	:	885,198	784,794	351,356	533,842
Propane	:	5,533	8,901	8,901	- 3,368
				TOTAL SAVINGS =	619,932

In constant FY 80 dollars, the cost of Wiesbaden's energy is projected to be $4,148,000 as compared to $5,950,000 : a savings of $1,802,000 per year in 1980 dollars.

4.1 ECIP Projects

Project documents have been prepared for energy conservation measures which qualify for ECIP funding. Volume III of the report contains completed DD Forms 1391 and Project Development Brochures for these projects.

The implementation of the energy conservation measures developed for ECIP funding will require an investment of $5,780,000 and result in an annual savings of 241,350 MBTU/yr. Assuming a discount rate of 10%, the discounted payback for the total investment would be 3.8 years.

PROJECT DESCRIPTION	ENERGY SAVED (MBTU/YR)	ENERGY SAVED ($/YR)	TOTAL INVESTMENT ($000)	SIR
Energy Conservation Improvements (OMA Facilities) o Building LTW Controls o Building LPS Controls o Lighting Replacement o Boiler Flue Gas Dampers o Boiler Turbulators o Prevent Air Stratification o Prevention of Air Stratification	19,300	115,800	391	4.0
Weatherization (OMA Facilities) o Vestibules o Roof Insulation o Double Glazed Windows o Thermal Barriers for Windows	61,350	349,000	1,541	3.2
Family Housing Weatherization o Roof Insulation o Double Glazed Windows	145,850	490,000	3,185	2.6
Thermostatic Radiator Valves (OMA Facilities)	6,300	47,370	330	1.9
Family Housing Heating Controls	8,550	28,370	333	1.5
Mess Hall Exhaust Air Heat Recovery*	3,840	23,900	254	1.4

*For implementation if exhaust systems are renovated.

4.2 Specific Operation and Maintenance Modifications

Recommendations for modification of the operation and maintenance of utility systems were developed from building operations survey data under Increment F of this study. These energy conservation measures are expected to save 39,382 MBTU/yr for a total investment of $56,950: at an estimated savings of $150,600/yr the investment will payback in less than 5 months. A listing of Increment F projects, ranked by ESIR, is included at the end of this volume as Exhibit A.

Project Description	Implementation Costs (materials)	Implementation Costs (man-hours)	Estimated Energy Savings (MBTU/yr)
Repair Vent Dampers and Seal Miscellaneous Openings in Building Envelopes	2,962	120	445
Reset Existing Heating System Controls and Thermostatic Valves	721	105	16,940
Insulate Valves in Heating Plant	2,150	12	173
Reduce Domestic Hot Water Temperature	515	39	5,388
Repair of Leaks in the Hot Water and Steam Distribution Systems	114	26	26
Insulate Hot Pipelines	10,848	802	9,291
Reduce Heating in Unoccupied Areas	3,451	174	6,091
Installation of Timers on Vending Machines	310	16	44
Reduction of Lighting by Lamp Removal	541	276	499
Install Additional Light Switches	1,158	100	161
Add Timers to Light Switches	3,362	234	316
Add Outdoor Light Controls	386	16	8
Total	26,518	1,920	39,382

4.3 General Operation and Maintenance Modifications

General opportunities for conservation in the operation and maintenance of utilities systems which have been recommended are summarized below:

PROJECT DESCRIPTION	ENERGY SAVINGS (MBTU/yr)	MATERIAL COST ($)	LABOR HOURS (Hours)
Night Temperature Setback The energy savings attainable through night and weekend temperature setback of intermittently occupied buildings was not applied to the ECIP projects for building heating system controls. After the controls are installed, setback of indoor temperature during unoccupied periods can be implemented for additional heating energy savings.	16,400	-	40
Domestic Hot Water Flow Control Where flow rates through shower heads and faucets are excessive, flow control devices are being installed to limit energy consumption.	20,100	15,000	650
Incandescent Lighting Replacement Many of the existing incandescent lighting fixtures and lamps can be replaced with higher efficiency flourescent lighting to reduce electricity consumption.	370	5,036	120

4.4 Recommendations for Electrical Load Management

Management of electrical loads creates opportunities for reducing operating costs. The methods recommended do not conserve a significant amount of energy but rather control the use of electrical energy in order to take fair advantage of utility rate schedules. The recommendations are summarized below.

	Cost Savings ($/yr)	Investment ($)
1. Load Shedding A demand limiting (ripple) control system can be installed to reduce peak demand utility charges by temporarily disconnecting certain loads during peak demand periods.	$17,250	124,500

2. Use of Standby Generators
If 50% of the presently installed standby generators were operated parallel with the utility for approximately nine hours each day in January to lower the annual peak demand, the rate paid for electrical energy throughout the year would be lowered. If policy could be changed to permit the use of generators in this manner, possible annual savings would be estimated as follows:

Wiesbaden Air Base	:	$44,840
Hainerberg Heating Plant	:	7,480
Hainerberg Commissary	:	6,730
Aukamm Heating Plant	:	3,890

	Cost Savings ($/yr)	Investment ($)

3. Power Factor Correction
   Installations of the Wiesbaden Military Community paying power factor penalties were studied to determine the most economical method of reducing these charges.

   Installation of capacitors is recommended to reduce power factor charges as shown at the following locations:

	Cost Savings ($/yr)	Investment ($)
Aukamm Heating Plant	$1,200	760
Aukamm School	400	337
Hainerberg Heating Plant	1,500	1,520
Hainerberg High School	300	560
Kastel Family Housing	2,500	2,800

4.5 Summary of Energy and Cost Savings

Potential energy and utility cost savings for Wiesbaden installations are summarized below.

	Energy Savings (MBTU/yr)	Cost Savings ($/yr)
ECIP Projects	241,350	$1,054,400
Specific Operation and Maintenance Recommendations	39,382	159,600
General Operation and Maintenance Recommendations	36,850	-
Recommendations for Load Shedding and Power Factor Correction	-	23,150
Optimum Transformer Loading	-	2,200
Total		$1,239,350

5.0 SPECIAL APPROACHES TO ENERGY UTILIZATION

Part of the EEA effort was directed toward special approaches to energy utilization with the goal of reducing dependency on critical fuels as well as well as reducing energy consumption. Renewable energy sources including solar, biomass, geothermal, wind and waste have general potential to replace petroleum and natural gas as fuels for space heating and hot water. For the current Wiesbaden applications waste-to-energy, geothermal and solar appeared to be technically feasible renewable energy sources. Other special approaches which have been successfully applied elsewhere were analyzed but found inappropriate for the specific application factors at Wiesbaden.

The conclusions of the various energy utilization approaches evaluated are summarized below:

Opportunity Investigated	Conclusion
Utilization of Wind Energy	Average wind velocities in Wiesbaden are too low for practical applications.
Geothermal Energy	Application of a geothermal heat pump system is technically feasible but not economically attractive. The largest #2 oil fired heating plant is about 40% of the size required for a life cycle cost effective application.
Biomass (Fuel Derived from Plant Life)	This technology is not commercially developed and the availability of fuel stock is unreliable.
Waste-to-Energy Systems - Refuse Derived Fuel	Hainerberg Housing Area is the only location which has a sufficient base load for burning the refuse collected throughout Wiesbaden. Although refuse burning is technically feasible it is not economically attractive to replace coal firing at Hainerberg.

Opportunity Investigated	Conclusion
Waste-to-Energy Systems (Cont'd) - Biogas	Biogas is not competitive with fossil fuels and does not have a potential for utilization in Wiesbaden.
- Sewage Gas	Cost effective utilization of sewage gas at Wiesbaden is not possible. If new sewage plants are constructed or major renovations made for other purposes, the utilization of sewage gas appears attractive.
- Pyrolysis of Municipal Refuse	This technology has not advanced far enough to be considered for commercial development.
Coal/Oil Mixtures	This technology is being developed for commercial demonstration. This fuel is not now available for commercial purchase.
Solar Energy	The most appropriate application of this proven technology at Wiesbaden is for heating domestic water. Analysis concluded that this application was not life cycle cost effective by ECIP criteria for ten buildings having the greatest application potential.
District Heating	Utilization of municipal district heating is very common in West Germany but no systems are located near enough to the Wiesbaden installations to be utilized.

EMCS applications studied for the Wiesbaden Community resulted in the recommendation of localized EMCS in the form of building heating system controls and remote limited function EMCS for peak demand limiting. The heating system controls bring significant energy savings to be incorporated in the ECIP projects. The demand limiting EMCS reduces utility charges but does not significantly save energy; this project must be funded through sources other than ECIP.

6.0 ENERGY PLAN

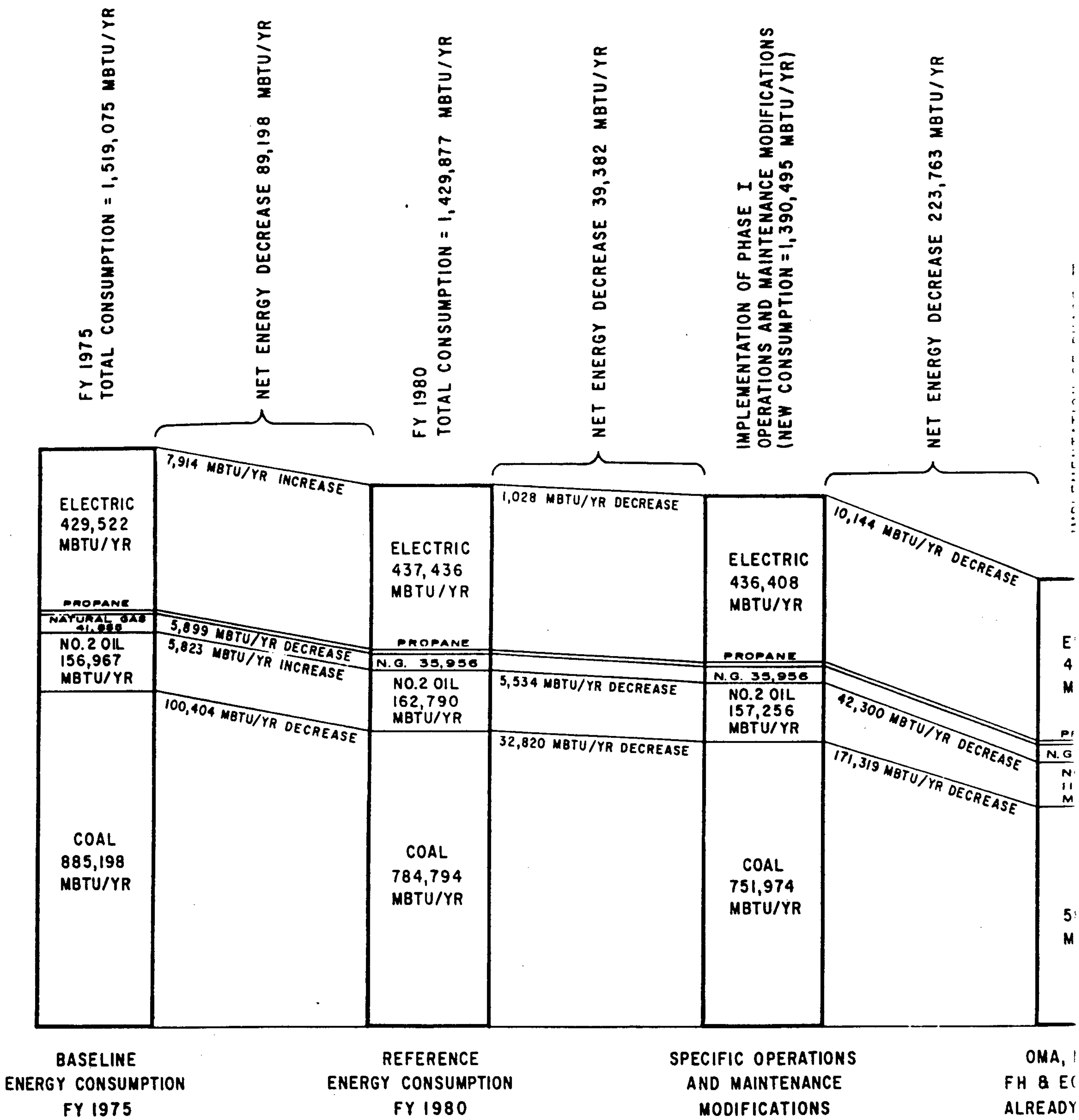
The "Basewide Energy Plan" as developed hereunder integrates ongoing energy conservation operations and maintenance activities, programmed ECIP Projects, programmed projects (which save energy) in the OMA, MMCA, MCA and FH categories and EEAP Study recommendations in both the operations and maintenance category and the capital (ECIP) improvement category.

Figure 6.1 graphically depicts the implementation of the following energy plan. Figure 6.2 shows the energy consumption/energy savings profile as a function of time. The baseline data is as follows:

FY 75 BASELINE ENERGY CONSUMPTION	: 1,519,075 MBTU/YR
CRITICAL FUEL (OIL & GAS) CONSUMPTION	: 198,822 MBTU/YR
ENERGY BUDGET KBTU/SF - YR	: 163.45

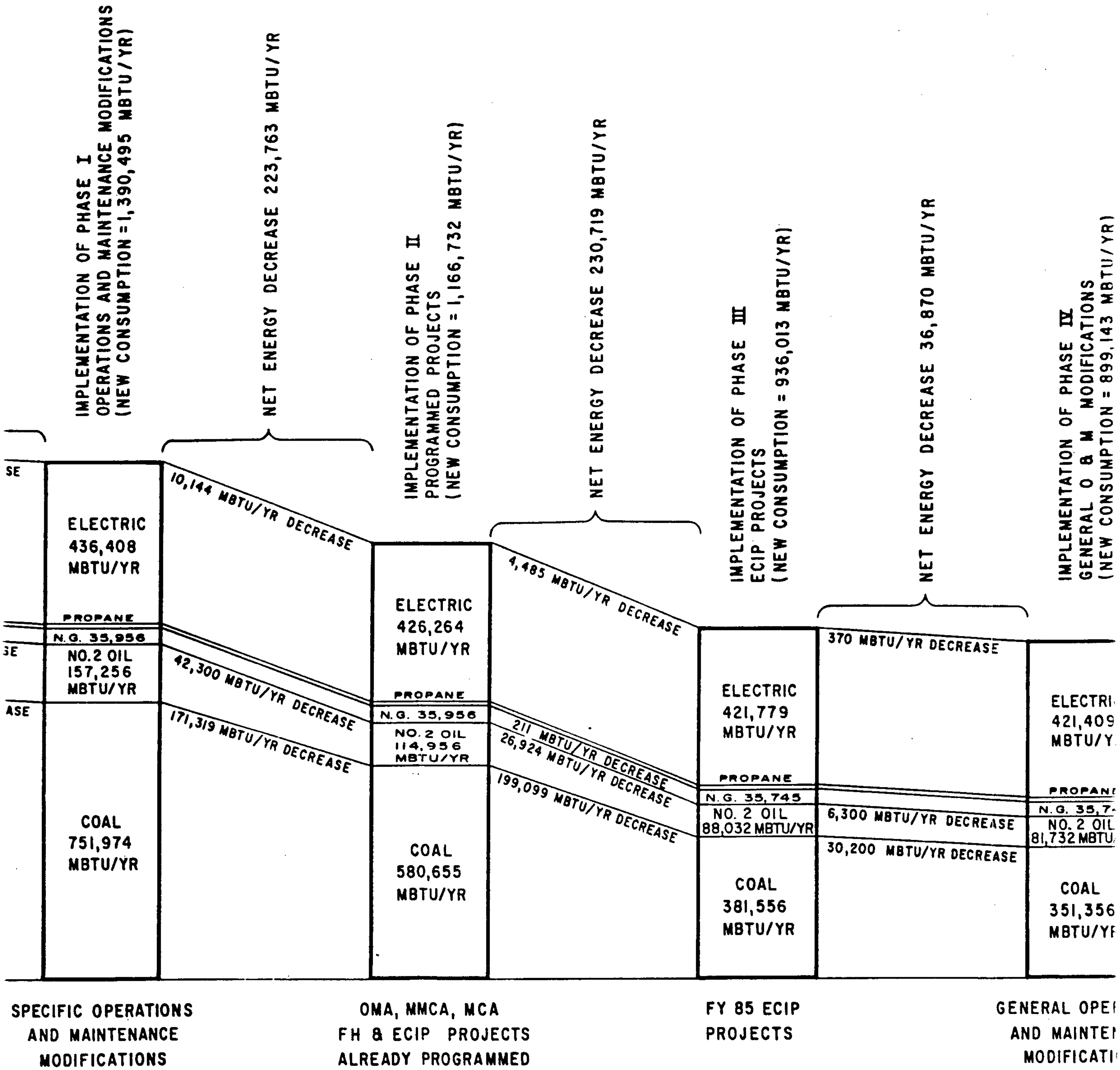
The reference year for this study is FY 80. The available data indicates that community energy conservation activities were able to effectively reduce total energy consumption as follows:

FY 80 REFERENCE ENERGY CONSUMPTION	: 1,429,877 MBTU/YR
% REDUCTION FROM BASELINE	: 5.87%
FY 80 CRITICAL FUEL (OIL & GAS) CONSUMPTION	: 198,746 MBTU/YR
ENERGY BUDGET KBTU/SF - YR	: 153.85



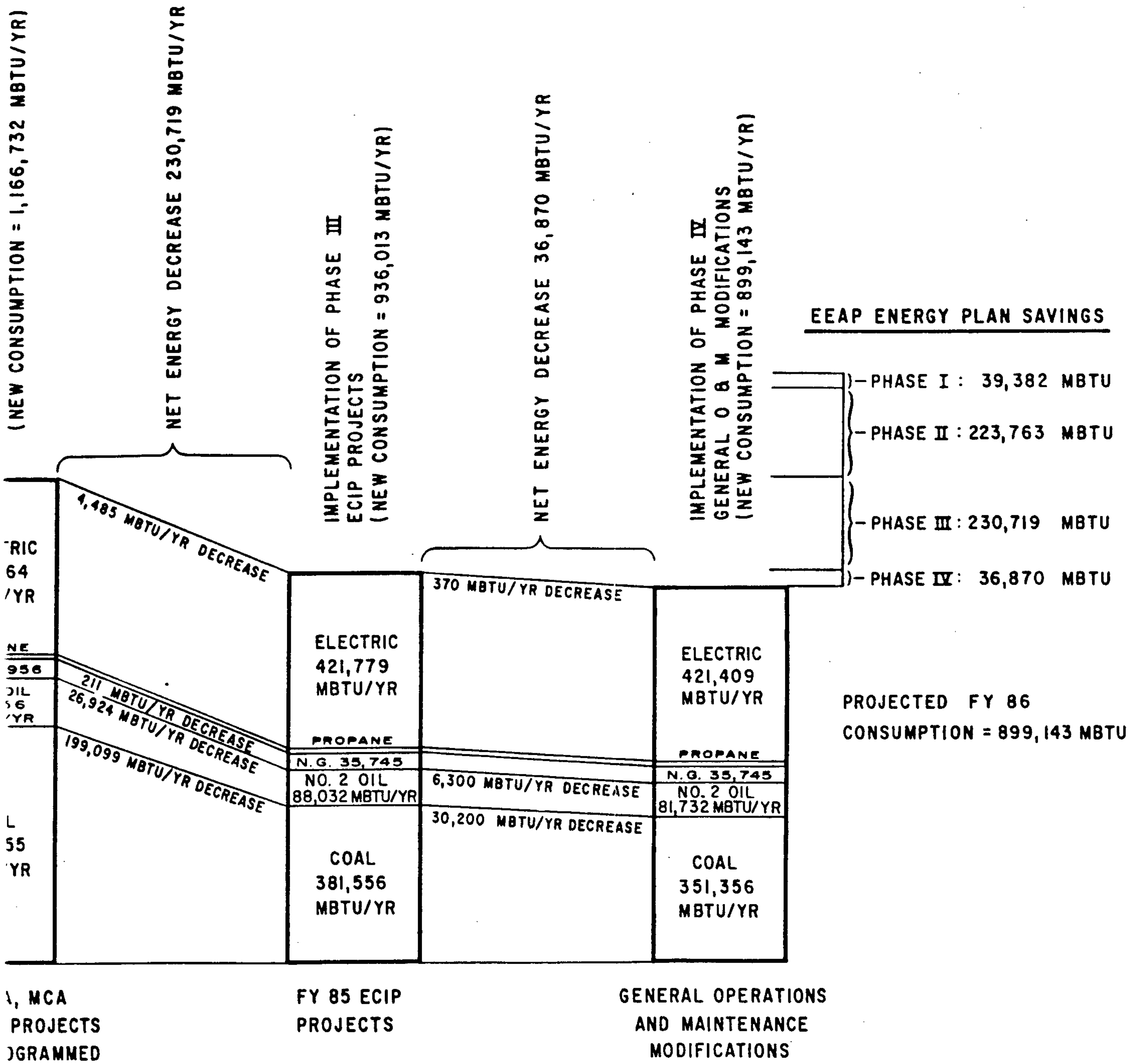
FY 1975
TOTAL CONSUMPTION = 1,519,075 MBTU/YR
NET ENERGY DECREASE 89,198 MBTU/YR
FY 1980
TOTAL CONSUMPTION = 1,429,877 MBTU/YR
NET ENERGY DECREASE 39,382 MBTU/YR
IMPLEMENTATION OF PHASE I
OPERATIONS AND MAINTENANCE MODIFICATIONS
(NEW CONSUMPTION = 1,390,495 MBTU/YR)
NET ENERGY DECREASE 223,763 MBTU/YR
ELECTRIC
429,522
MBTU/YR
PROPANE
NATURAL GAS
41,855
NO. 2 OIL
156,967
MBTU/YR
COAL
885,198
MBTU/YR
7,914 MBTU/YR INCREASE
5,899 MBTU/YR DECREASE
5,823 MBTU/YR INCREASE
100,404 MBTU/YR DECREASE
ELECTRIC
437,436
MBTU/YR
PROPANE
N.G. 35,956
NO.2 OIL
162,790
MBTU/YR
COAL
784,794
MBTU/YR
1,028 MBTU/YR DECREASE
5,534 MBTU/YR DECREASE
32,820 MBTU/YR DECREASE
ELECTRIC
436,408
MBTU/YR
PROPANE
N.G. 35,956
NO.2 OIL
157,256
MBTU/YR
COAL
751,974
MBTU/YR
10,144 MBTU/YR DECREASE
42,300 MBTU/YR DECREASE
171,319 MBTU/YR DECREASE
N.G
BASELINE
ENERGY CONSUMPTION
FY 1975
REFERENCE
ENERGY CONSUMPTION
FY 1980
SPECIFIC OPERATIONS
AND MAINTENANCE
MODIFICATIONS

1



IMPLEMENTATION OF PHASE I
OPERATIONS AND MAINTENANCE MODIFICATIONS
(NEW CONSUMPTION = 1,390,495 MBTU/YR)
NET ENERGY DECREASE 223,763 MBTU/YR
IMPLEMENTATION OF PHASE II
PROGRAMMED PROJECTS
(NEW CONSUMPTION = 1,166,732 MBTU/YR)
NET ENERGY DECREASE 230,719 MBTU/YR
IMPLEMENTATION OF PHASE III
ECIP PROJECTS
(NEW CONSUMPTION = 936,013 MBTU/YR)
NET ENERGY DECREASE 36,870 MBTU/YR
IMPLEMENTATION OF PHASE IV
GENERAL O & M MODIFICATIONS
(NEW CONSUMPTION = 899,143 MBTU/YR)
SE
SE
ASE
ELECTRIC
436,408
MBTU/YR
PROPANE
N.G. 35,956
NO.2 OIL
157,256
MBTU/YR
COAL
751,974
MBTU/YR
10,144 MBTU/YR DECREASE
42,300 MBTU/YR DECREASE
171,319 MBTU/YR DECREASE
ELECTRIC
426,264
MBTU/YR
PROPANE
N.G. 35,956
NO.2 OIL
114,956
MBTU/YR
COAL
580,655
MBTU/YR
4,485 MBTU/YR DECREASE
211 MBTU/YR DECREASE
26,924 MBTU/YR DECREASE
199,099 MBTU/YR DECREASE
ELECTRIC
421,779
MBTU/YR
PROPANE
N.G. 35,745
NO. 2 OIL
88,032 MBTU/YR
COAL
381,556
MBTU/YR
370 MBTU/YR DECREASE
6,300 MBTU/YR DECREASE
30,200 MBTU/YR DECREASE
ELECTRI
421,409
MBTU/Y
PROPAN
N.G. 35,7
NO. 2 OIL
81,732 MBTU
COAL
351,356
MBTU/YF
SPECIFIC OPERATIONS
AND MAINTENANCE
MODIFICATIONS
OMA, MMCA, MCA
FH & ECIP PROJECTS
ALREADY PROGRAMMED
FY 85 ECIP
PROJECTS
GENERAL OPE
AND MAINTE
MODIFICATI

2



3

EEAP ENERGY PLAN

FIG. 6.1

EEAP ENERGY PLAN

Energy Consumption/Savings Profile

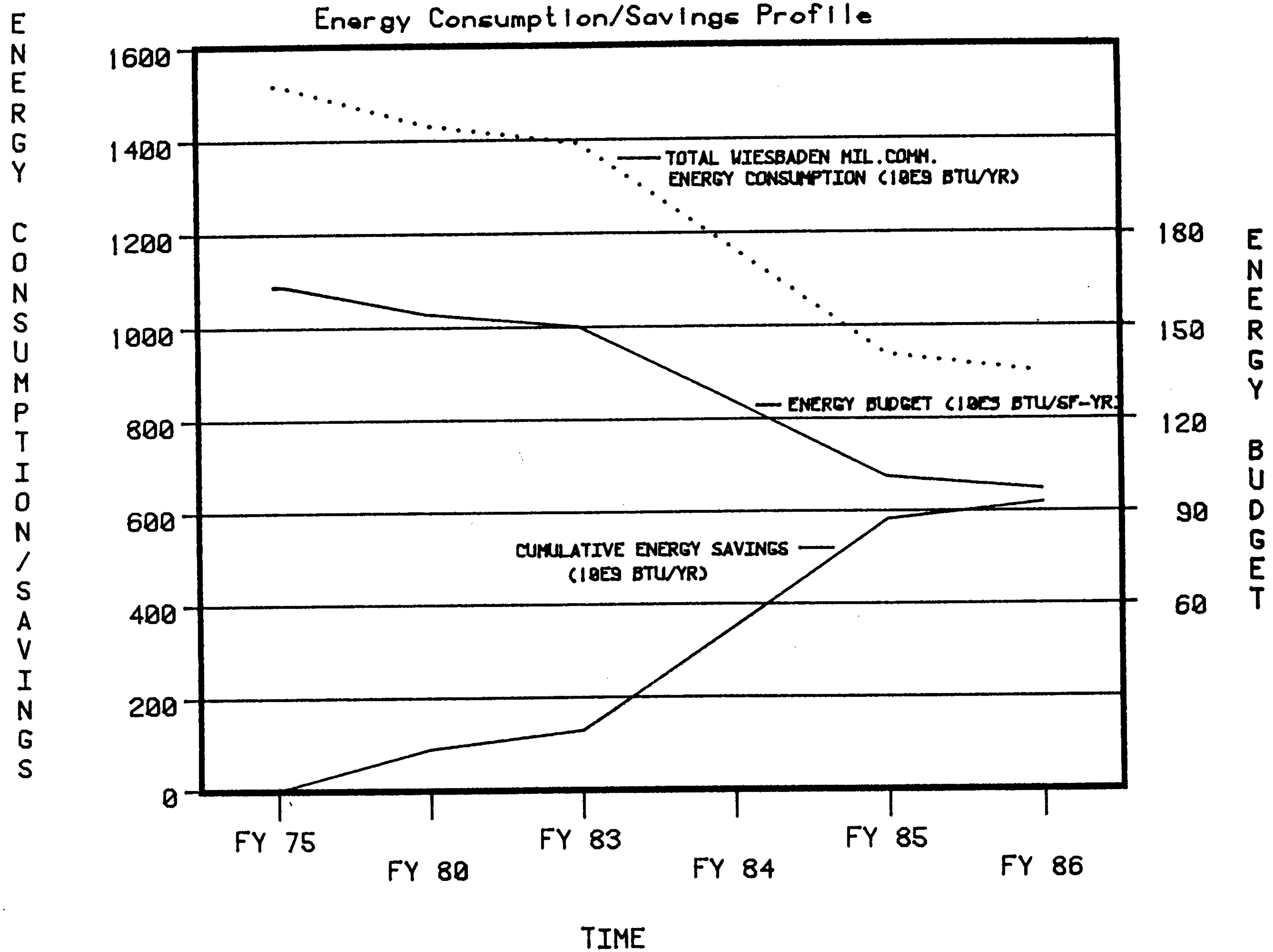


Figure 6.2

Phase I of the energy plan is the implementation of specific operations and maintenance type modifications (para. 4.2). Using in-house labor these modifications can be made relatively quickly and can be done inexpensively; collectively, they will yield a payback of less than two months and reduce the total annual energy consumption as follows:

Upon Completion of Phase I:

TOTAL ENERGY CONSUMPTION	: 1,390,495 MBTU/YR
% REDUCTION (CUMULATIVE) FROM BASELINE	: 8.46%
CRITICAL FUEL (OIL & GAS) CONSUMPTION	: 193,212 MBTU/YR
ENERGY BUDGET KBTU/SF - YR (10^3)	: 149.6

Phase II of the energy plan is a part of the ongoing energy conservation efforts of the Wiesbaden Military Community. The anticipated savings for this phase are derived from those projects which have already been programmed by the community and are in various stages of approval, design or construction. The savings projections for this phase, approximately 223,763 MBTU/yr, are per community documentation. The Wiesbaden Air Base Central Heating Plant project is vital to the achievement of the Phase II goal; this project accounts for 42% of Phase II energy savings (94,000 MBTU/yr) including a reduction in no. 2 fuel oil of 43,740 MBTU/yr. The total annual energy consumption will be reduced as follows:

Upon Completion of Phase II :

TOTAL ENERGY CONSUMPTION	: 1,166,732 MBTU/YR
% REDUCTION (cumulative) FROM BASELINE	: 23.2%

CRITICAL FUEL
(OIL & GAS) CONSUMPTION : 150,912 MBTU/YR

ENERGY BUDGET
KBTU/SF - YR (10^3) : 125.54

Phase III of the energy plan is the implementation of energy conservation measures as recommended herein (para. 4.1) and chosen by the community for implementation. Project documentation has already been developed for the Phase III projects and been sent forward for approval on FY 85 projects. The savings projection for this phase is 230,719 MBTU/yr. The reduction of total annual energy consumption is as follows:

Upon Completion of Phase III :

TOTAL ENERGY
CONSUMPTION : 936,013 MBTU/YR

% REDUCTION (CUMULATIVE)
FROM BASELINE : 38.4%

CRITICAL FUEL
(OIL & GAS) CONSUMPTION : 123,777 MBTU/YR

ENERGY BUDGET
KBTU/SF - YR : 100.7

Phase IV of the energy plan is the implementation of general operations and maintenance type measures. Most of these measures have not been quantified because they are either accomplished during the normal course of maintenance, are maintenance activities necessary to maintain level of savings achieved through other energy savings measures or are monitoring activities which are necessary in order to achieve success in any energy conservation plan. These general operations and maintenance type measures are discussed in Sections 6.3 and 6.4 of Volume II: Study Report. The savings projection for this phase is 36,870 MBTU/yr. The reduction of total annual energy consumption is as follows:

Upon Completion of Phase IV:

TOTAL ENERGY CONSUMPTION	: 899,143 MBTU/YR
% REDUCTION (CUMULATIVE) FROM BASELINE	: 40.8%
CRITICAL FUEL (OIL & GAS) CONSUMPTION	: 117,477 MBTU/YR
ENERGY BUDGET KBTU/SF - YR	: 96.7

Implementation of this energy conservation plan will result in several coincident energy reductions on the same buildings. Care was taken so as not to duplicate energy savings within the secondary systems or between the primary and secondary systems; therefore, in view of the conservative approach taken in energy savings calculations, the predicted savings are achievable. However, a program for monitoring the progress of the energy plan and gauging the savings is of the utmost importance; this is necessary to identify problems in meeting goals as early on in the program as is feasible.

Figure 6.3 presesnts a matrix of the energy conservation projects versus savings and costs.

6.1 Army Facilities Energy Plan Goals

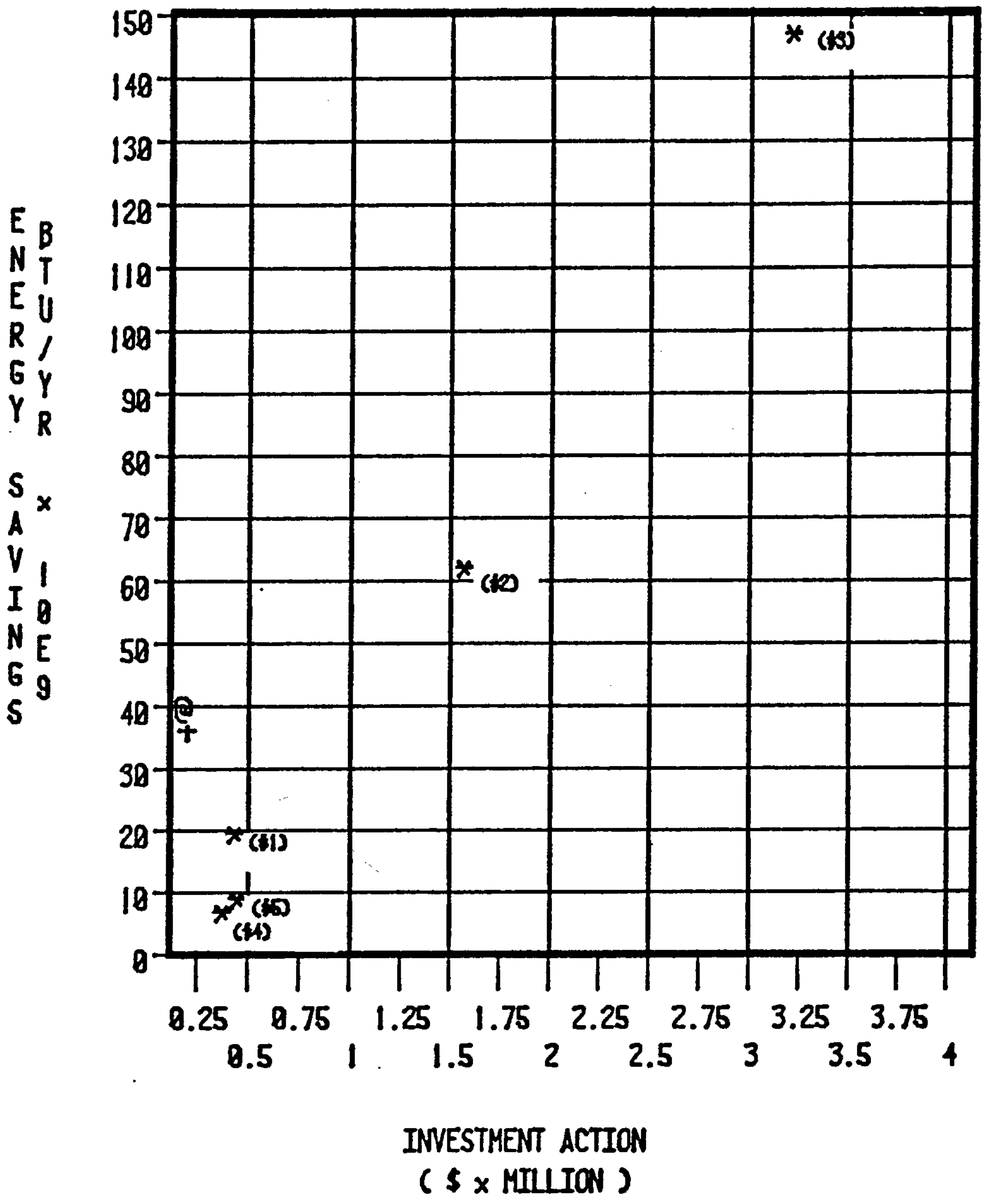
The above described plan was developed to reduce energy consumption at the Wiesbaden Military Community in accordance with the goals of the Army Facilities Energy Plan.

A comparison of the goals of the Army Facilities Energy Plan and the findings and results of this study is made in Table 6.4.

FIGURE 6.3

ACTION-SAVINGS MATRIX

EEAP ENERGY PLAN



LEGEND

@ – SPECIFIC OPERATIONS AND MAINTENANCE ECO's (SIR > 30)

* – ECIP DD FORM 1391: #1:Energy Conservation Improvements-OMA (SIR=4.0)
#2:Weatherization-OMA (SIR=3.2)
#3:Family Housing Weatherization (SIR=2.6)
#4:Thermostatic Radiator Valves (SIR=1.9)
#5:Family Housing Heating Controls (SIR=1.5)

+ – GENERAL OPERATIONS AND MAINTENANCE ECO's (SIR > 30)

NOTE:PHASE II PROGRAMMED PROJECTS NOT INCLUDED ABOVE

TABLE 6.4

	ARMY FACILITIES ENERGY PLAN	EEAP ENERGY PLAN
YEAR 1985 GOALS	a. Reduce Army installation and activity energy consumption by 25% of that consumed in FY 75 as the base year.	a. Energy consumption reductions to date in combination with recommended operations and maintenance modifications, programmed projects and recommended ECIP projects will serve to reduce annual consumption by over 40%.
	b. Reduce average annual energy consumption per gross square foot of floor area by 20% in existing facilities compared to FY 75 as the base year. At least 12% of the energy reduction in existing buildings shall be accomplished through energy conservation projects under the Energy Conservation Investment Program (ECIP).	b. The average annual energy consumption will be reduced from 163,930 BTU/SF - YR to 97,200 BTU/SF - YR upon complete implementation of the plan; this is a 40.7% reduction. The EEAP ECIP projects will save an estimated 15.2% of FY 75 consumption of existing facilities; this coupled with community-programmed ECIP projects will far exceed the goal.
	c. Reduced average annual energy consumption per gross square foot of floor area by 45% in new buildings compared to FY 75 as the base year.	c. This shall be accomplished by proper review and monitoring throughout the design phase.
	d. Reduce dependence on critical fuels:	d.
	1. Obtain at least 10% of total Army installation energy from coal, coal gasification, solid waste, refuse derived fuel and biomass.	1. Over 80% of the existing facilities are currently heated by coal.
	2. Equip all natural gas only heating units and plants over 5 MEGA BTU per hour output with the capability to use oil or other alternate fuels.	2. Wiesbaden Military Community does not have any natural gas only heating units over 5 MEGA BTU.
	3. To have on hand at the beginning of each heating season a 30-day fuel supply for all oil only, oil - natural gas, and coal heating units over 5 MEGA BTU per hour output based upon the coldest month recorded and in a mobilization condition.	3. This shall be accomplished through implementation of proper procurement regulations.
	4. Obtain 1% of total Army installation energy by solar means.	4. Based on analysis of solar applications for the Wiesbaden area, solar energy projects should be concentrated in other geographical areas where the project economics are expected to be very attractive.
	5. Restrict the use of electric resistance heating to those applications prescribed in ETL 1110-3-254.	5. Survey data did not indicate that electric resistance heating was being used in Wiesbaden installations. In communities where building heating control systems had been installed, use of portable electric heaters in barracks and family housing was reported. This illustrates the need to institute tight controls over unauthorized use of private electric resistance heaters.
	6. Require the energy efficiency ratios of new windows air conditioning units to be 8.5 or greater for 120 volt units and 8.0 or greater for 230 volt units.	6. Air conditioning units are not generally installed at the Wiesbaden installations. Recommendations for purchase of energy conservation design options on replacement equipment are included in Section 6 of Volume II.

TABLE 6.4 (continued)

	ARMY FACILITIES ENERGY PLAN	EEAP ENERGY PLAN
YEAR 2000 GOALS	a. Reduce Army installation and activity energy consumption by 50% of that consumed in FY 75.	a. This goal, although difficult to attain, is within reach. By implementing the EEAP Plan, the existing structures and utility systems will have been modified with those conservation measures now practical; this will reduce FY 75 energy consumption by almost 41%. Through proper maintenance, these savings should be maintained through 2000. The additional 9% savings will be achieved by the construction of new more efficient facilities, replacement of inefficient equipment through attrition and general maintenance and operations measures (not quantified) discussed in Volume II; heating plants should be the primary targets for replacement of existing equipment with higher efficiency equipment.
	b. Reduce dependence on critical fuels. 1. Eliminate use of natural gas. 2. Reduce the use of petroleum fuels in installations operations by 75%.	b. These goals can be met through conventional technology. The EEAP Plan shows a reduction of 50% in critical fuels. The most logical approach to further reduction in critical fuels would be repair by replacement of oil-fired heating plants (oil to coal conversion) and repair by replacement of gas-fired hot water heaters(gas to LPS/LTW).

INCREMENT F OPERATION AND MAINTENANCE ECO SUMMARY

BLDG	CONSERVATION OPTION	MBTU/YR	$/YR	TOTAL $ COST	ESIR	SIR	MANHOURS	L.T.	REF.
7001	Reset Heat Plant Controls	13,141	44,155	12	61,830.4	61,830.4	1	1	02
1007	Reduce DHW Temperature	1,268	4,260	12	5,965.7	5,965.7	1	1	04
7534	Reduce DHW Temperature	688	2,311	12	3,236.1	3,236.1	1	1	04
1203	Reduce DHW Temperature	426	1,431	12	2,004.0	2,004.0	1	1	04
7535	Reduce DHW Temperature	416	1,399	12	1,958.7	1,958.7	1	1	04
7531	Reduce DHW Temperature	407	1,368	12	1,915.4	1,915.4	1	1	04
1204	Reduce DHW Temperature	365	1,227	12	1,717.7	1,717.7	1	1	04
7532	Reduce DHW Temperature	359	1,208	12	1,690.9	1,690.9	1	1	04
3113	Reduce Chapel Heat	149	1,257	12	1,299.0	1,299.0	1	1	10
1255	Reduce DHW Temperature	157	526	12	736.3	736.3	1	1	04
7530	Reduce DHW Temperature	153	514	12	720.4	720.4	1	1	04
7536	Reduce DHW Temperature	144	485	12	678.5	678.5	1	1	04
7532	Reset Heat Controls	523	1,759	49	615.6	615.6	4	1	02
1207	Reduce DHW Temperature	122	409	12	572.6	572.6	1	1	04
7531	Reset Heat Controls	438	1,473	49	515.8	515.8	4	1	02
1001	Reduce DHW Temperature	106	357	12	500.4	500.4	1	1	04
1258	Reduce DHW Temperature	93	312	12	437.3	437.3	1	1	04
1217	Reset Thremo. Rad. Valves	684	2,298	98	402.2	402.2	8	1	02
3123	Reset Heat Controls	156	1,315	49	339.9	339.9	4	1	02
3110	Reset Thermo. Rad. Valves	294	2,479	98	320.3	320.3	8	1	02
1021	Reduce DHW Temperature	32	267	12	276.5	276.5	1	1	04
4018	Reduce DHW Temperature	61	274	12	274.7	274.7	1	1	36
7053	Reduce DHW Temperature	54	181	12	252.8	252.8	1	1	04
4001	Reset Thermo. Rad. Valves	346	2,915	147	251.1	251.1	12	1	02
4010	Reduce DHW Temperature	41	183	12	183.2	183.2	1	1	36
4007	Red. DHW Temp (Mens Room)	36	160	12	160.3	160.3	1	1	36
1026	Reduce DHW Temperature	27	92	12	128.4	128.4	1	1	04
1056	Reduce In House DHW Temp.	27	89	12	124.8	124.8	1	1	04
1013	Reset Bsmt.Ofc.Rad.Valves	365	1,226	195	107.3	107.3	16	1	02
1205	Reset Thermo. Rad. Valves	473	1,588	293	92.6	92.6	24	1	02
1212	Reduce DHW Temperature	19	65	12	91.2	91.2	1	1	04
1033	Reduce DHW Temperature	16	55	12	77.5	77.5	1	1	04
7531	Stop Heating Loft	1,536	5,161	1,270	69.5	69.5	40	1	10
7532	Stop Heating Loft	1,536	5,161	1,270	69.5	69.5	40	1	10
7535	Stop Heat Loft	1,536	5,161	1,270	69.5	69.5	40	1	10
3106	Insulate Hot Ceiling Pipe	702	5,908	1,076	69.3	69.3	40	3	07
3107	Insulate Hot Ceiling Pipe	702	5,908	1,076	69.3	69.3	40	3	07
3109	Insulate Hot Ceiling Pipe	702	5,908	1,076	69.3	69.3	40	3	07
1019	Reduce Chapel Heat	14	46	12	64.2	64.2	1	1	10
7533	Stop Heating Loft	1,302	4,374	1,270	58.9	58.9	40	1	10
3111	Reduce DHW Temperature	7	57	12	58.7	58.7	1	1	04
3122	Rep. & Reset Rad. Valves	520	4,382	977	56.6	56.6	24	1	02
3110	Insulate Hot Ceiling Pipe	863	7,267	1,721	53.3	53.3	64	3	07
7533	Insulate Steam Lines	403	1,355	638	36.3	36.3	24	3	07
1011	Ins. Pipe In Unhtd. Space	235	791	401	33.7	33.7	16	3	07

REF: calculation reference number in appendix
L.T.: labor type

INCREMENT F OPERATION AND MAINTENANCE ECO SUMMARY (Cont'd)

BLDG	CONSERVATION OPTION	MBTU/YR	$/YR	TOTAL COST $	ESIR	SIR	MANHOURS	L.T.	REF.
7531	Ins. Hot Attic Piping	1,275	4,284	2,750	26.6	26.6	120	3	07
7532	Ins. Hot Attic Piping	1,275	4,284	2,750	26.6	26.6	120	3	07
7534	Ins. Hot Attic Piping	1,275	4,284	2,750	26.6	26.6	120	3	07
7535	Ins. Hot Attic Piping	1,275	4,284	2,750	26.6	26.6	120	3	07
1006	Ins. Basement Hot Piping	279	936	655	24.4	24.4	32	3	07
3122	Fix Hot Faucet Leak	5	46	24	23.6	23.6	2	1	06
3102	Ins. Hot Basement Pipe	178	1,499	1,014	18.7	18.7	40	3	07
5301	Delamp Main Kitchen 50%	59	266	175	18.6	18.6	16	2	38
7762	Delamp Main Store	14	62	44	17.5	17.5	4	2	38
1029	Reduce DHW Temperature	202	678	684	17.0	17.0	16	1	04
7054	Insulate HW Return Line	79	264	321	14.1	14.1	10	3	07
7762	Delamp Laundry 50%	45	200	175	14.0	14.0	16	2	38
7762	Delamp Drinks Hall	11	50	44	14.0	14.0	4	2	38
7762	Delamp Glass Storeroom	6	25	22	14.0	14.0	2	2	38
7053	Insulate HW Return Line	31	103	139	12.6	12.6	8	3	07
5119	Delamp Class Halls, 50%	19	83	87	11.6	11.6	8	2	38
5119	Delamp Classroom, 50%	14	62	66	11.6	11.6	6	2	38
3101	Repair Vent Dampers,12	104	871	1,026	10.7	10.7	24	1	01
3104	Repair Vent Dampers,12	104	871	1,026	10.7	10.7	24	1	01
3105	Repair Vent Dampers,12	104	871	1,026	10.7	10.7	24	1	01
7762	Delamp Stereo Store	17	75	87	10.5	10.5	8	2	38
7762	Delamp Canteen	17	75	87	10.5	10.5	8	2	38
1069	Add 5 Light Switches	93	416	507	10.0	10.0	24	2	39
1202	Hall Light Timer, 1	8	37	46	9.9	9.9	2	2	40
7762	Delamp Dry Cleaners 25%	16	71	87	9.9	9.9	8	2	38
4001	Seal Tank Entry Door	6	52	69	9.4	9.4	4	4	09
7535	Delamp Storage 160W	4	17	22	9.3	9.3	2	2	38
7762	Delamp Locker Room	4	17	22	9.3	9.3	2	2	38
1026	Delamp 24 Fixtures, 960W	22	100	131	9.3	9.3	12	2	38
3107	Doors for Vehic. Exhaust	22	186	253	9.3	9.3	16	4	09
3109	Doors for Vehic. Exhaust	22	186	253	9.3	9.3	16	4	09
3122	Repair Vent Damper	9	75	110	8.6	8.6	4	1	01
3112	Repair Vent Damper	9	73	110	8.3	8.3	4	1	01
1007	Bath Light Timers, 6	42	187	278	8.2	8.2	12	2	40
1015	Bath Lighting Timer	7	31	46	8.2	8.2	2	2	40
4006	Insulate 7 Steam Valves	159	1,343	2,227	7.6	7.6	8	3	03
1007	Delamp 27 Fixtures, 1KW	23	104	175	7.3	7.3	16	2	38
1201	Delamp Halls 50%	22	100	175	7.0	7.0	16	2	38
1202	Delamp 16 Fixtures, 640W	22	100	175	7.0	7.0	16	2	38
1203	Delamp Halls 50%	22	100	175	7.0	7.0	16	2	38
1204	Delamp Halls 50%	22	100	175	7.0	7.0	16	2	38
1206	Delamp Halls 50%	22	100	175	7.0	7.0	16	2	38
1207	Delamp Halls 50%	22	100	175	7.0	7.0	16	2	38
1060	Delamp 6 Fixtures, 240W	6	25	44	7.0	7.0	4	2	38
1069	Delamp 6 Fixtures, 240W	6	25	44	7.0	7.0	4	2	38

INCREMENT F OPERATION AND MAINTENANCE ECO SUMMARY (Cont'd)

BLDG	CONSERVATION OPTION	MBTU/YR	$/YR	TOTAL COST $	ESIR	SIR	MANHOURS	L.T.	REF.
1016	Delamp 12 Fixtures, 480W	11	50	87	7.0	7.0	8	2	38
1066	Delamp 12 Fixtures, 480W	11	50	87	7.0	7.0	8	2	38
1069	Hall Light Timer	6	25	46	6.6	6.6	2	2	40
7530	Inst. Kit. Vent Dampers	50	169	440	6.6	6.6	16	1	01
3102	Timer on Drink Machine,2	14	62	117	6.5	6.5	4	2	34
3112	Timer on Drink Machine	7	31	58	6.5	6.5	2	2	34
7039	Insulate HW Return Line	17	57	152	6.4	6.4	8	3	07
7762	Repair Shop Vent Damper	12	41	110	6.3	6.3	4	1	01
1016	Vending Machine Timer	6	28	58	5.9	5.9	2	2	34
4010	Timer on Drink Machine	6	28	58	5.9	5.9	2	2	34
1015	Delamp 10 Fixtures, 400W	9	42	87	5.8	5.8	8	2	38
3111	Seal Gaps in Skylight	3	23	57	5.1	5.1	4	4	09
1016	Bath Light Timer, 1	4	19	46	4.9	4.9	2	2	40
4008	Timer on Drink Machine	5	23	58	4.9	4.9	2	2	34
1008	Delamp 2 Fixtures, 160W	4	17	44	4.7	4.7	4	2	38
1009	Delamp 2 Fixtures, 160W	4	17	44	4.7	4.7	4	2	38
5010	Delamp Workshop 50%	6	29	87	4.1	4.1	8	2	38
1066	Office Therm. Rad. Valves	14	47	195	4.1	4.1	8	1	08
5301	Hall Light Timers	93	416	1,268	4.0	4.0	40	2	40
7211	Fix Manhole Steam Leak	18	59	256	3.9	3.9	16	1	06
1014	Delamp Halls 50%	9	42	131	3.9	3.9	12	2	38
7762	Add Canteen Lt. Switches	17	75	253	3.6	3.6	12	2	39
1007	Shutoff 3 Ent. Hall Rad.	18	62	293	3.6	3.6	12	1	08
1010	Stair Light Timers, 2	6	27	93	3.6	3.6	4	2	40
1015	Laundry Lighting Timer, 1	3	12	46	3.3	3.3	2	2	40
1016	Stair Light Timers, 2	6	25	93	3.3	3.3	4	2	40
1060	Storage Light Timer, 1	3	12	46	3.3	3.3	2	2	40
1062	Hall Light Timer	3	12	46	3.3	3.3	2	2	40
7272	Basement Light Timer	3	12	46	3.3	3.3	2	2	40
7275	Basement Light Timer	3	12	46	3.3	3.3	2	2	40
7530	Basement Light Timer	3	12	46	3.3	3.3	2	2	40
7531	Basement Light Timer	3	12	46	3.3	3.3	2	2	40
7532	Basement Light Timer	3	12	46	3.3	3.3	2	2	40
7534	Basement Light Timer	3	12	46	3.3	3.3	2	2	40
7535	Basement Light Timer	3	12	46	3.3	3.3	2	2	40
7537	Basement Light Timer	3	12	46	3.3	3.3	2	2	40
1006	Basement Light Timer	4	17	68	3.0	3.0	4	2	40
1004	Add 3 Light Switches	19	87	358	3.0	3.0	16	2	39
1214	Vending Machine Timers, 2	6	28	117	2.9	2.9	4	2	34
1007	Entrance Light Timer	2	10	46	2.7	2.7	2	2	40
1009	Hall Light Timers, 2	5	21	93	2.7	2.7	4	2	40
1010	Basement Light Timers, 3	7	31	139	2.7	2.7	6	2	40
7762	Change Spotlights to 50W	26	117	557	2.6	2.6	4	2	38
1004	Delamp 2 Fixtures, 80W	2	8	44	2.3	2.3	4	2	38
1008	Bath Light Timers, 2	4	17	93	2.2	2.2	4	2	40

INCREMENT F OPERATION AND MAINTENANCE ECO SUMMARY (Cont'd)

BLDG	CONSERVATION OPTION	MBTU/YR	$/YR	TOTAL $ COST	ESIR	SIR	MANHOURS	L.T.	REF.
7796	Hall Light Timers, 2	4	17	93	2.2	2.2	4	2	40
7289	Basement Light Timer	2	8	46	2.2	2.2	2	2	40
7290	Basement Light Timer	2	8	46	2.2	2.2	2	2	40
7292	Basement Light Timer	2	8	46	2.2	2.2	2	2	40
7302	Basement Light Timer	2	8	46	2.2	2.2	2	2	40
7536	Basement Light Timer	2	8	46	2.2	2.2	2	2	40
1026	Add Light Switch	6	25	149	2.1	2.1	8	2	39
3101	Add Game Room Lt. Switch	4	17	105	1.9	1.9	4	2	39
3104	Add Game Room Lt. Switch	4	17	105	1.9	1.9	4	2	39
3105	Add Game Room Lt. Switch	4	17	105	1.9	1.9	4	2	39
3101	Light Timers,2 Stairwells	9	42	278	1.8	1.8	12	2	40
3103	Light Timers,2 stairwells	9	42	278	1.8	1.8	12	2	40
3104	Light Timers,2 Stairwells	9	42	278	1.8	1.8	12	2	40
3105	Light Timers,2 Stairwells	9	42	278	1.8	1.8	12	2	40
3115	Light Timers,2 Stairwells	9	42	278	1.8	1.8	12	2	40
7009	Bsmnt. Hall Lt. Timers, 2	3	12	93	1.6	1.6	4	2	40
7726	Basement Light Timers, 2	3	12	93	1.6	1.6	4	2	40
7799	Storage Hall Lt. Timers,2	3	12	93	1.6	1.6	4	2	40
7804	Storage Hall Lt. Timers,2	3	12	93	1.6	1.6	4	2	40
7806	Storage Hall Lt. Timers,2	3	12	93	1.6	1.6	4	2	40
7008	Basement Hall Light Timer	1	6	46	1.6	1.6	2	2	40
7268	Basement Light Timer	1	6	46	1.6	1.6	2	2	40
7273	Basement Light Timer	1	6	46	1.6	1.6	2	2	40
7274	Basement Light Timer	1	6	46	1.6	1.6	2	2	40
7704	Basement Light Timer	1	6	46	1.6	1.6	2	2	40
7761	Ins. Header Block Valves	14	47	534	1.5	1.5	4	3	03
1019	Add Office Light Switch	3	12	105	1.5	1.5	4	2	39
1250	Basement Light Timers, 5	3	16	139	1.4	1.4	6	2	40
5401	Basement Light Timers	4	19	185	1.2	1.2	8	2	40
7762	Add Main Str. Lt.Switches	11	50	507	1.2	1.2	24	2	39
1252	Basement Light Timers, 2	2	8	93	1.1	1.1	4	2	40
1253	Basement Light Timers, 2	2	8	93	1.1	1.1	4	2	40
1255	Basement Light Timer, 2	2	8	93	1.1	1.1	4	2	40
1256	Basement Light Timers, 2	2	8	93	1.1	1.1	4	2	40
1257	Basement Light Timers, 2	2	8	93	1.1	1.1	4	2	40
1258	Basement Light Timers, 2	2	8	93	1.1	1.1	4	2	40
4002	Stairwell Light Timer	3	12	139	1.1	1.1	6	2	40
7032	Bsmnt. Hall Lt. Timers, 2	2	8	93	1.1	1.1	4	2	40
7034	Bsmnt. Hall Lt. Timers, 2	2	8	93	1.1	1.1	4	2	40
7533	Repair Cond. Pipe Leak	3	10	159	1.1	1.1	8	1	06